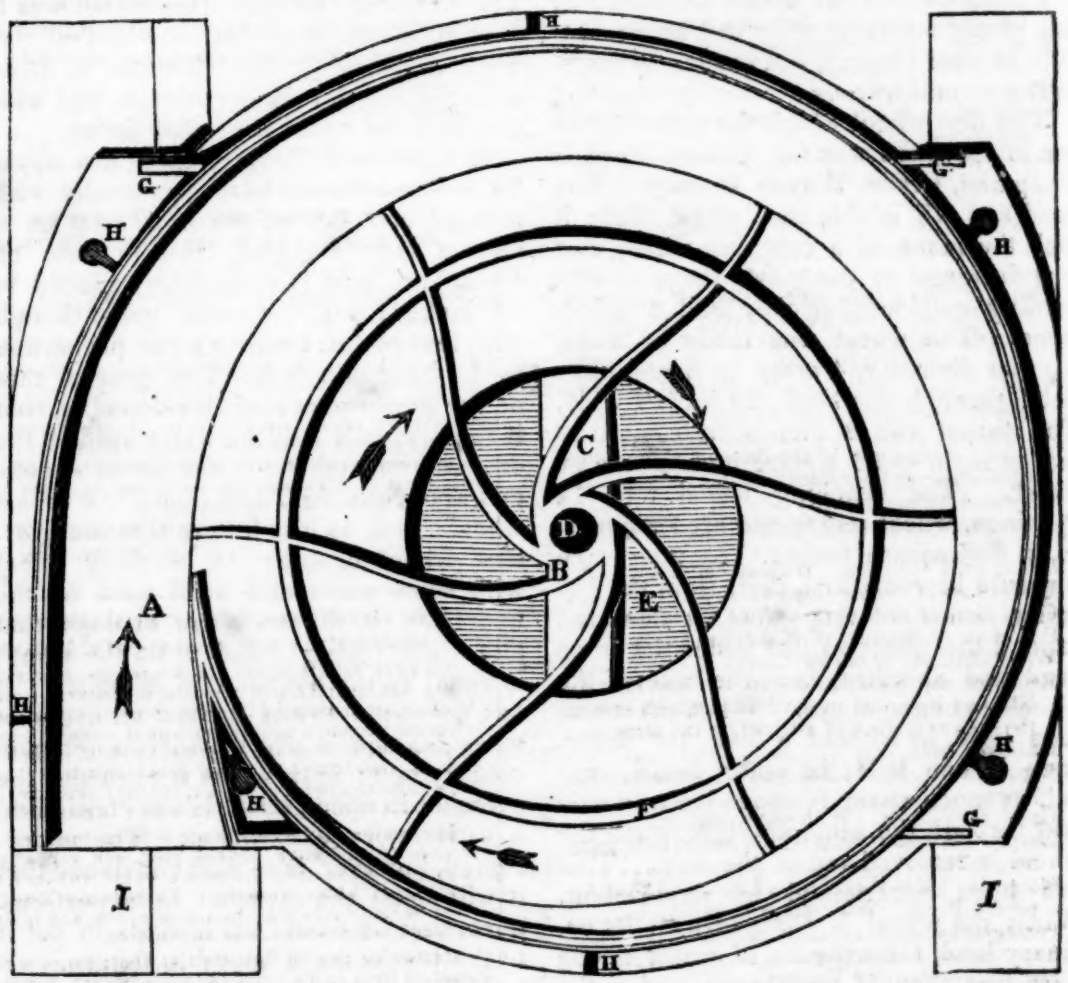
MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME V.] MAY, 1835. [NUMBER 5.

EASTMAN'S CENTRAL DISCHARGING WATER-WHEEL.



New-York, March 18th, 1835.

To the Editor of the Mechanics' Magazine:

SIR,—I herewith forward you a drawing of Joel Eastman's Central-discharging Water Wheel, patented lately. The inventor died before he had brought it to that degree of perfection it has now attained. The undersigned being a joint patentee, has devoted considerable attention to this wheel, in order that he might present it to the public for their patronage, in a form that would do them, and the wheel itself, justice. This, he thinks, has now been fully attained. During the last year, many of them have been built and put in motion in the western part of New-York, with a degree of success unprecedented. The wheel is adapted to all degrees of head and fall. It runs as well in backwater as out of it, the head being the same. In cold climates, where the ice is troublesome, this wheel is a re-

lief from the difficulty, as it can be so placed that ice cannot form near it. It may be wholly buried in water to effect this object; in which case the shaft must be surrounded with a water-tight case, to prevent the water from coming into the wheel around the shaft, as that would injure its action.

In many instances this wheel has been put in comparison with those before in use, and in every instance the comparison has been very much in its favor. A few facts on this point will be stated in this place, believing they will be acceptable to your readers, and especially interesting to mill owners.

The first wheel which the undersigned put in operation was for Messrs. Ford & Chapman, Clyde, Wayne County. The head and fall in this case was 4 feet; it took the place of a reaching wheel, and was designed to carry two large double carding machines, pecker, and a grindstone. The wheel was made of wood, 4½ feet diameter, 4 arms, or floats, morticed through the shaft, 12 inches wide. The throat was 8 inches wide, and 12 inches high, = 96 square inches area of water. The reaching wheel had 12 openings, whose aggregate area amounted to 336 square inches. In this place it should be remarked, that, from the peculiar nature of this wheel, it does not expend the water so fast under the same head and aperture, as in the case of the wheels in common use. When the wheel runs light, or without a load, the difference is one half; in other words, only half as much water is expended as would flow through the same aperture when the wheel is removed out of the way. This has been ascertained by experiment. When the wheel is charged with its ordinary load, the expense of water is one third less than if discharged under the same head and aperture on an undershot wheel; so that in the case above, where the aperture was 96 inches, the expense was only equal to 62 inches.

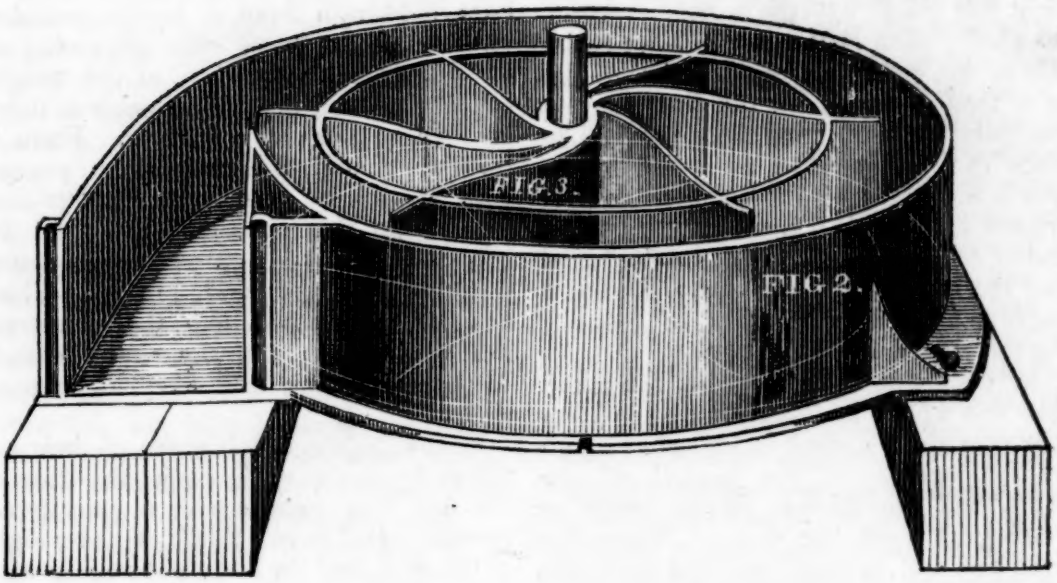
When this wheel was set to work, it was found to exert more power than the reaching wheel, which the millwrights in this case judged consumed from four to six times as much water. When the operation of fulling commenced, this wheel was found able to finish a stock of cloth in six hours that used to require eight hours by the reaching wheel. This wheel was built and put in motion in three days by four men, and, as may be supposed from the above statement, gave great satisfaction. The proprietors, among the most intelligent mill owners in the State, unsolicited, have furnished me with a statement of the performance of this wheel, certified.

Another wheel was put in motion in Eldridge. It took the place of a tub wheel, 6½ feet diameter, which received 280 inches of water. This wheel was 5 feet 10 inches, used just one half of the water required by the tub wheel to drive a pair of heavy rock cornstones, and with one half the water it ground faster.

In Courtland County, there are about 20 of these wheels in use, generally with a head and fall of about 5 feet, on a stream very sluggish, and in time of floods the head is sometimes reduced to 16 inches; still the wheel goes, though with less power, bearing a just proportion to the head and fall. The general rate of the performance of this wheel is, that it requires only half the water used on the ordinary undershot, tub, and flutter wheels, and about one third less than a low breast wheel; and, as it is known that the overshot wheel doubles the working effect with some water and head used by the undershot, it follows from analogy that this wheel (being found to do the same) is equal to the overshot in its effect. It has not been tested against an overshot wheel, except in one instance, a common country mill; in this case it exceeded the overshot in effect, but it is not considered a satisfactory experiment. The undersigned, however, is so well convinced that it will equal the overshot in its performance, that he would not hesitate to put it to the test under a heavy forfeiture.

Millwrights, generally, when they first see the plan, are inclined to treat it with utter contempt; which, in every case that has come under observation has been subdued. When they have seen the wheel at work, they uniformly give it up, and admit that it excels all other wheels for low heads, although its being so small and simple puzzles them to account for the effect.

This wheel is also well adapted for saw-mills. When used for this purpose, the shaft is usually placed horizontal, and



the wheel vertical. If the head is less than 6 feet, then the best way to apply it to sawing is to form the wheel of its usual size, varying from 4 to 6 feet, according to head and fall, and gear to the crank shaft by two small bevel wheels. There are several saw mills in operation on both of these plans; that is, when the motion is given directly to the crank shaft by the wheel being on it, and by gearing. The accompanying drawing represents one of these wheels, made entirely of cast iron, except seven screw bolts, to secure it in its place upon a foundation of bed timbers. Fig. 1 represents a plan. Fig. 2, a view of the same in perspective. The circle in which the wheels revolve is 4½ feet, about medium size. Fig. 3 shows the wheel in its place, the floats being connected and supported by a ring of iron near their extremities. A represents the throat, by which the water is admitted, 10 wide by 13 high, forming an aperture of 130 square inches. B on the plan represents the wheel; C, the bed piece, supporting the step of the shaft; D, the shaft; E, the opening in the bottom of the case containing the wheel, by which the water is discharged, 2 feet in diameter, equal to 452 square inches. The general rule is, to make the discharging circular opening about four times the dimensions of the aperture by which the water is admitted on the wheel. F, the ring of support to the floats. G G G, brackets to add strength. H H, &c., holes and notches, to admit of bolts to secure the whole together, and to the bed timbers. I I, bed timbers.

The top of the case, in which the wheel revolves, is not shown in the drawing; it is made to fit on the top edge of the rim, forming the spiral exterior of the wheel; a groove of slight depth is formed in it, to admit of making it tight. The throat enlarges outward, and at its extremity on either side is provided with vertical grooves, the more readily to admit of connecting it with the flume. A wheel of this size will weigh from 2000 to 2500 lbs., and can be put up, all expense included, for about $150. Nearly all the wheels in use are made of wood, in the following manner, viz.: a course of 2½ or 3 inch plank is laid level in the bed timbers; the rim, or circumference, is formed of timber framed together at the corners, and curved out so as to form the proper inside shape. The top is to be formed also of plank jointed together, and the whole well secured together; an opening must be left through the top, to admit the shaft to turn freely, without rubbing.

The periphery of the wheel case varies as much from a true circle as is equal to the breadth of the throat. A convenient mechanical method of generating this spiral curve is as follows: when the breadth of the throat is determined on, prepare a circular piece of wood, whose circumfer-

lief from the difficulty, as it can be so placed that ice cannot form near it. It may be wholly buried in water to effect this object; in which case the shaft must be surrounded with a water-tight case, to prevent the water from coming into the wheel around the shaft, as that would injure its action.

In many instances this wheel has been put in comparison with those before in use, and in every instance the comparison has been very much in its favor. A few facts on this point will be stated in this place, believing they will be acceptable to your readers, and especially interesting to mill owners.

The first wheel which the undersigned put in operation was for Messrs. Ford & Chapman, Clyde, Wayne County. The head and fall in this case was 4 feet; it took the place of a reaching wheel, and was designed to carry two large double carding machines, pecker, and a grindstone. The wheel was made of wood, 4½ feet diameter, 4 arms, or floats, morticed through the shaft, 12 inches wide. The throat was 8 inches wide, and 12 inches high, = 96 square inches area of water. The reaching wheel had 12 openings, whose aggregate area amounted to 336 square inches. In this place it should be remarked, that, from the peculiar nature of this wheel, it does not expend the water so fast under the same head and aperture, as in the case of the wheels in common use. When the wheel runs light, or without a load, the difference is one half; in other words, only half as much water is expended as would flow through the same aperture when the wheel is removed out of the way. This has been ascertained by experiment. When the wheel is charged with its ordinary load, the expense of water is one third less than if discharged under the same head and aperture on an undershot wheel; so that in the case above, where the aperture was 96 inches, the expense was only equal to 62 inches.

When this wheel was set to work, it was found to exert more power than the reaching wheel, which the millwrights in this case judged consumed from four to six times as much water. When the operation of fulling commenced, this wheel was found able to finish a stock of cloth in six hours that used to require eight hours by the reaching wheel. This wheel was built and put in motion in three days by four men, and, as may be supposed from the above statement, gave great satisfaction. The proprietors, among the most intelligent mill owners in the State, unsolicited, have furnished me with a statement of the performance of this wheel, certified.

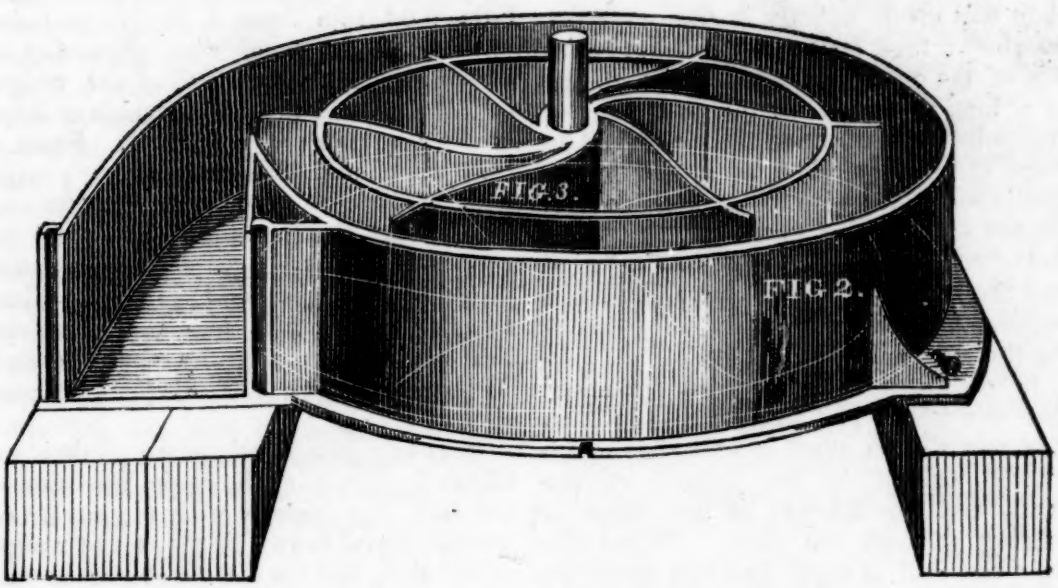
Another wheel was put in motion in Eldridge. It took the place of a tub wheel, 6½ feet diameter, which received 280 inches of water. This wheel was 5 feet 10 inches, used just one half of the water required by the tub wheel to drive a pair of heavy rock cornstones, and with one half the water it ground faster.

In Courtland County, there are about 20 of these wheels in use, generally with a head and fall of about 5 feet, on a stream very sluggish, and in time of floods the head is sometimes reduced to 16 inches; still the wheel goes, though with less power, bearing a just proportion to the head and fall. The general rate of the performance of this wheel is, that it requires only half the water used on the ordinary undershot, tub, and flutter wheels, and about one third less than a low breast wheel; and, as it is known that the overshot wheel doubles the working effect with some water and head used by the undershot, it follows from analogy that this wheel (being found to do the same) is equal to the overshot in its effect. It has not been tested against an overshot wheel, except in one instance, a common country mill; in this case it exceeded the overshot in effect, but it is not considered a satisfactory experiment. The undersigned, however, is so well convinced that it will equal the overshot in its performance, that he would not hesitate to put it to the test under a heavy forfeiture.

Millwrights, generally, when they first see the plan, are inclined to treat it with utter contempt; which, in every case that has come under observation has been subdued. When they have seen the wheel at work, they uniformly give it up, and admit that it excels all other wheels for low heads, although its being so small and simple puzzles them to account for the effect.

This wheel is also well adapted for saw-mills. When used for this purpose, the shaft is usually placed horizontal, and

PAGINATION INCORRECT



the wheel vertical. If the head is less than 6 feet, then the best way to apply it to sawing is to form the wheel of its usual size, varying from 4 to 6 feet, according to head and fall, and gear to the crank shaft by two small bevel wheels. There are several saw mills in operation on both of these plans; that is, when the motion is given directly to the crank shaft by the wheel being on it, and by gearing. The accompanying drawing represents one of these wheels, made entirely of cast iron, except seven screw bolts, to secure it in its place upon a foundation of bed timbers. Fig. 1 represents a plan. Fig. 2, a view of the same in perspective. The circle in which the wheels revolve is 4½ feet, about medium size. Fig. 3 shows the wheel in its place, the floats being connected and supported by a ring of iron near their extremities. A represents the throat, by which the water is admitted, 10 wide by 13 high, forming an aperture of 130 square inches. B on the plan represents the wheel; C, the bed piece, supporting the step of the shaft; D, the shaft; E, the opening in the bottom of the case containing the wheel, by which the water is discharged, 2 feet in diameter, equal to 452 square inches. The general rule is, to make the discharging circular opening about four times the dimensions of the aperture by which the water is admitted on the wheel. F, the ring of support to the floats. G G G, brackets to add strength. H H, &c., holes and notches, to admit of bolts to secure the whole together, and to the bed timbers. I I, bed timbers.

The top of the case, in which the wheel revolves, is not shown in the drawing; it is made to fit on the top edge of the rim, forming the spiral exterior of the wheel; a groove of slight depth is formed in it, to admit of making it tight. The throat enlarges outward, and at its extremity on either side is provided with vertical grooves, the more readily to admit of connecting it with the flume. A wheel of this size will weigh from 2000 to 2500 lbs., and can be put up, all expense included, for about $150. Nearly all the wheels in use are made of wood, in the following manner, viz.: a course of 2½ or 3 inch plank is laid level in the bed timbers; the rim, or circumference, is formed of timber framed together at the corners, and curved out so as to form the proper inside shape. The top is to be formed also of plank jointed together, and the whole well secured together; an opening must be left through the top, to admit the shaft to turn freely, without rubbing.

The periphery of the wheel case varies as much from a true circle as is equal to the breadth of the throat. A convenient mechanical method of generating this spiral curve is as follows: when the breadth of the throat is determined on, prepare a circular piece of wood, whose circumfer-

ence is equal to the breadth of the throat; plant this circle exactly in the centre of the shaft; then fasten a small wire to the side of the circle opposite the throat, and in a loop prepared for the purpose, put the point of the scribe, and proceed to trace the curve; when an entire revolution is made, the wire will be wound once around the circular plane in the centre, and of course the radius will be shortened just the breadth of the throat. This is a convenient and true method of generating the required spiral curve.

In conclusion, it may be remarked that this wheel is entirely new; in form it is very simple, small in bulk, having no friction except on the journal of the shaft, and the friction of the water in passing through the case. When the head and fall is eight feet and upwards, no gearing is necessary to give the proper motion to millstones; and when the head of water is below eight feet, single gearing, quite small, is all that is necessary. This wheel runs nearer the motion of the water than any other; and from the known effects of its operation, it clearly proves that water, when acting by its impulsive force, if such force can be intercepted, as is the case in this wheel, yields its maximum effect, equal gravity.

Having thus, sir, at some length, given a description of this new wheel, and the mode in which it may be constructed, should you deem it worthy, you are at liberty to give it a place in your valuable journal. The right to use this invention in all the States and Territories, except Delaware, New-Jersey, New-York, and the Eastern States, is not disposed of. Persons wishing to purchase the right for a State, County, Town, River, or a single dam, will be met on liberal terms by addressing me, post-paid, at this place. The wheel must, in all cases, be properly portioned to the head and fall in any given case, and the power required.

Yours respectfully,

JOHN MARTINEAU.

PROOF OF FOREIGN BRASS ARTILLERY.—The battering train and garrison artillery in the Prussian service are proved with a quantity of powder equal to half the weight of the shot, and fired seventy-five rounds as fast as in real service; that is, two or three rounds in a minute. Their light field-train from a twelve pounder upwards are proved with a quantity of powder equal to one third of the weight of the shot, and fired 150 rounds at three or four rounds in a minute. From a twelve pounder downwards are proved with a quantity of powder equal to one fifth of the shot's weight, and fired 30 rounds at five or six rounds each minute, properly sponged and loaded. Their mortars are proved with the chambers full of powder and the shells loaded. Three rounds are fired as quick as possible.

Secondly, the Dutch prove all their artillery by firing each piece five times; the first two rounds with a quantity of powder equal to two thirds of the weight of the shot, and the last three rounds with a quantity of powder equal to half the weight of the shot.—[Partington.]

[For the Mechanics' Magazine.]

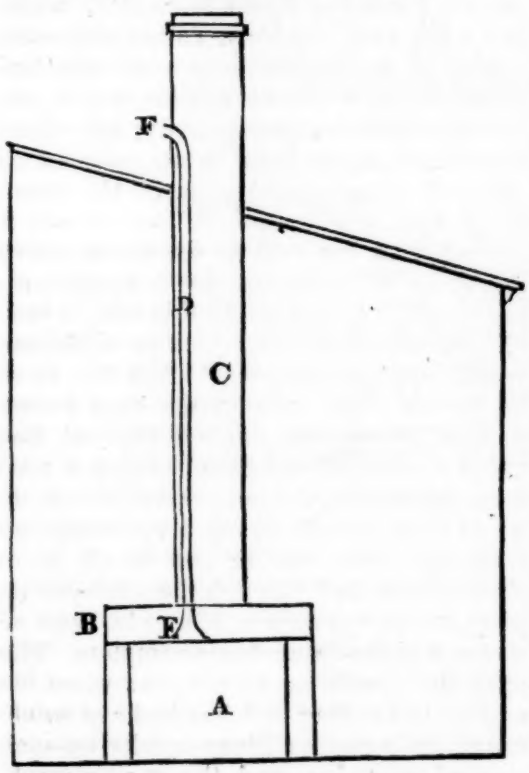
Smoky Chimneys.

An article in a late number of your journal recals to my mind a plan of curing smoky chimneys, which I saw practised in Paris when I was a student of medicine there, about twenty years since. As this plan succeeded entirely in the case referred to, and as it is not known or practised, so far as I can learn, in this country, and as, moreover, it is applicable to the worst conditions of chimneys, for carrying smoke well, I mean those of low buildings, adjoining or surrounded by such as are higher, I am of opinion that it may be adopted with great advantage.

The room which I occupied was on the ground floor of a two story building, on one side of an enclosed square, of which the three other sides were occupied by high buildings. The fireplace was large and open. I had it contracted a la Rumford. Still the smoke poured down in such volumes as to render it impossible for me to keep a fire, and I was about abandoning my quarters, for which I had paid a three months' advance of rent, when, at the suggestion of the porter, I sent for a chimney doctor. He brought with him two pails full of plaster of Paris, a hammer, and a cylinder of wood about eighteen inches long, and two or three

inches in diameter. I say cylinder: it was, more strictly speaking, a truncated cone, the diameter of one end being a little smaller than the other.

The doctor went up the chimney, and with his hammer made a hole through one side of the chimney, just above the roof. This hole was about large enough for a man's arm to enter. Now, placing the stick or cylinder, which he had greased, inside of the chimney, from opposite to the hole downwards, he called for some timbered plaister; he formed around the cylinder a pipe opening downwards. By successive formations, he continued this pipe down to the lower part of the chimney breast, where it terminated with a flattened opening. This he called a ventouse, or blower.



A, chimney, or section of fireplace.
B, chimney breast.
C, chimney.
D, the ventouse, or blower.
E, the lower flattened end of the blower.
F, the upper end of the blower, where it admits the external air.

The operation of this contrivance, for which a tin or copper leader might be substituted, will be evident to any one acquainted with the subject. The air within the cavity of the chimney being rarified heat, has a tendency to rise in it, and so has the smoke, which is specifically lighter. This tendency may be resisted by several causes. The chimney throat may not be large enough to let *all* the smoke ascend and pass out. It may be too large; if so, the cold air will enter at the top of the chimney, and, descending, will mix with and cool the smoke and heated air arising from the fire; thus causing a circulation within the chimney. This is a very frequent cause of smoky chimneys. A third cause is an insufficient supply of external air through the doors and windows; hence, some of the supply comes down the chimney. A fourth cause is a draught of air from the room to another room or fireplace, causing a similar descent. The plan I have described is calculated to remedy smoky chimneys from any and all these causes. The air descends through the blower, and supplies a sufficiency for the draught of the chimney. If it is in excess, it enters and cools the room. I am, &c. &c.

MEDICUS.

For the Mechanics' Magazine.]

Divisibility of Matter.

A Mr. *Boyle* sets forth many curious arguments to show how little we comprehend the extension of matter.

He speaks of a silken thread 300 English ells long, that weighed only $2\frac{1}{2}$ grs.

He measured gold leaf, and found that 50 square inches weighed but one grain. If the length of an inch be divided into 200 parts, the eye may distinguish them all; therefore, there are in one square inch of gold 40,000 visible parts, and in one grain of gold there are 2,000,000 of such parts, which visible parts (no one will deny) can be further divided.

A whole ounce of silver can be gilt with 8 grains of gold, which is afterwards drawn into a wire 13,000 feet long.

The weight of the gold is $\frac{1}{160}$ of the weight of the silver. When the weights are equal, a piece of gold is to a piece of silver as 10 to 19; therefore, the bulk of gold with which the silver is covered, is to the bulk of the silver as 1 to 114, for 10 : 19 : : 60 : 114.

A cubic foot of water weighs $62\frac{1}{2}$ lbs.; silver is ten times heavier; then, a cubic foot of silver weighs 635 lbs.

A cube is to a cylinder of the same

diameter and height as 14 to 11 nearly; then the weight of a cylindric foot of silver is 499 lbs. or 7984 ounces.

One ounce is drawn out into a wire of 14,000 feet, and in a cylindric foot there is contained a wire of 111,776,000 feet in length: that is, there are so many wires, each one foot long.

The surfaces of circles are as the squares of their diameters; therefore, the square of the diameter of the wire is to the square of one foot as 1 to 111,776,000; the roots of which numbers are 1 and 10,572, in which ratio the diameters mentioned are; therefore, the diameter of the wire is $\frac{1}{10572}$ of a foot, or $\frac{1}{881}$ of an inch. Gold is put round it, and the bulk is increased $\frac{1}{114}$, that is, the circular section of the wire is so much increased in consequence of a thin plate being put round it, the thickness of one fourth part of the $\frac{1}{114}$ part of the diameter; for the area of the circle is found by multiplying the circumference by the fourth part of the diameter.

Therefore, the thickness of the gold is $\frac{1}{456}$ of the diameter of the wire, which is $\frac{1}{881}$ of an inch; so the thickness of the gold is $\frac{1}{401716}$ of an inch.

These small gilt wires are made flat, that they may be wound on silk thread, when their surface is at least three times as great as before, and the thickness of the gold is diminished, so that it is only $\frac{1}{1205268}$.

The wire is not equally gilt in all parts, and the thickness of the gold in some places perhaps is twice as thick as in others; I shall, therefore, not exceed the truth if I put the thickness, where it is least, at $\frac{1}{2006006}$ of an inch; that is, the thousandth part of an inch is divided into two thousand parts.

Gold is thus actually divided; and in a golden sphere, one inch diameter, there are 8,000,000,000,000,000,000 of such parts; and in a very small grain of sand, whose diameter is the hundredth part of an inch, there are 8,000,000,000,000 such particles; and one of these particles is to the grain of sand as the grain of sand is to a globe which exceeds 16 feet diameter; for this globe would not contain a greater number of these grains of sand than a grain of sand would of such particles. This globe contains 4096 globes of one foot diameter each.

Although the above statement to many may appear incredible, yet when they consider how very thin gold leaf is plated, or beat, they may readily conclude the statement is correct, and by those who are acquainted with decimal arithmetic, the facts may easily be proved, as the data is given to work from.

S. A.

The writer of the following communication will please accept our thanks for this, and give us other communications for the Mechanics' Magazine.

New Method of Working Expansion Valves.

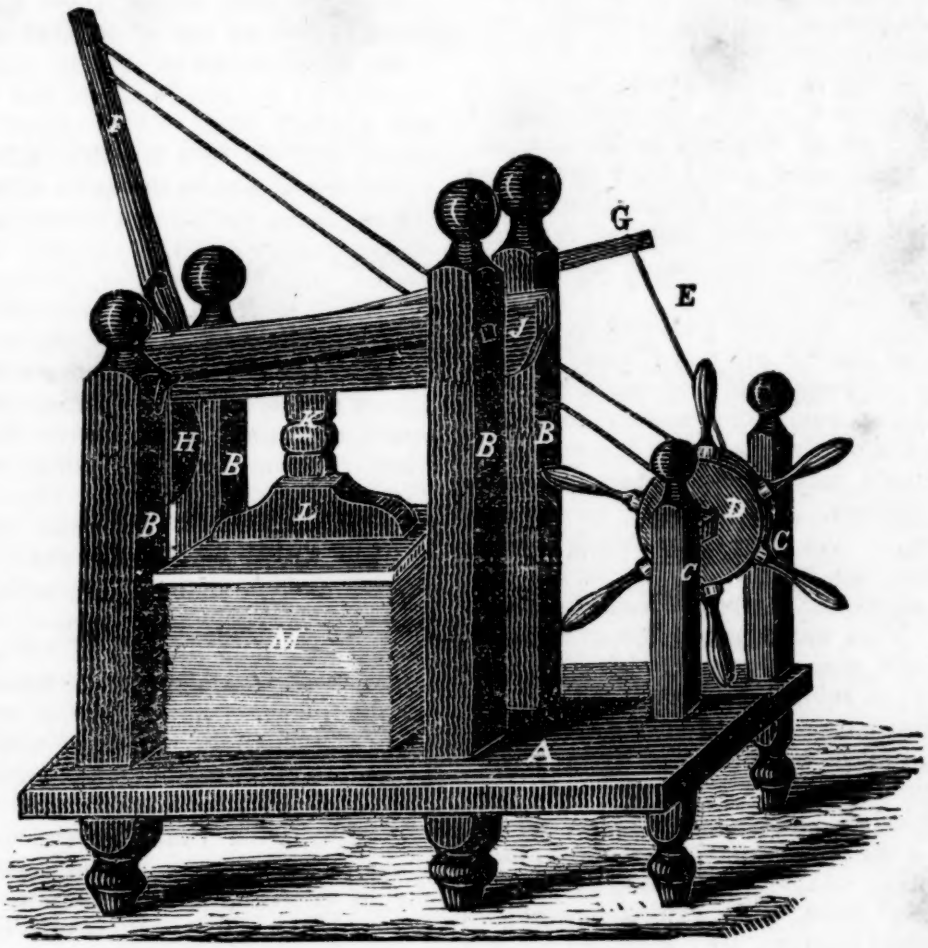
Ovid, N. Y., March 24, 1835.

To the Editor of the Mechanics' Magazine:

Sir,—In your number for the present month, I observe a new method of working what are commonly called *expansion valves*, by machinery connected with the governor of a steam engine, which deserves credit for its ingenuity, but which appears to me to be quite too complicated to be of any practical utility. On examining the specification of the above, it occurred to me that an expansion valve might be so contrived as to be self-acting; and in carrying out this idea, I concluded that something like the following would operate well, viz.: Let the valve be pretty large, and of the kind called puppet valves—to the spindle of this valve a spring is attached, having a constant tendency to open the valve, which, when open, should be but a little distance from its seat—one or two small holes should be drilled through the valve, or its plate, so as to cause a trifling leakage of steam, and the apparatus is complete. The operation would be as follows: when the engine is standing still, the leakage would cause the steam to press equally on each side of the valve, and the spring would draw it open—when the piston moves, the steam would become somewhat expanded in the cylinder, at about half the length of the stroke—the valve would then be closed by the superior pressure of the steam upon its upper side, and remain closed during the remainder of the stroke—at the end of the stroke there would be a short interval, during which both feeding valves are closed against the steam from the boiler—during this time the leakage would fill the valve-box,

and again produce an equilibrium of pressure upon each side of the valve, when it would again open, and again be closed as before. Such a valve would also operate in some measure as a governor.

VIS INERTIÆ.



[For the Mechanics' Magazine.]

Description of Scripture's Power-Press.

On the platform, A, stand six posts, four long, B B B B, and two short, C C. Between the latter is suspended the windlass, D, upon a horizontal shaft, to which is attached one end of the rope, E, which passes in an inclined direction over a sheave in the upper end of an elevated post, F, the foot of which is secured by bolts, or staples, upon one of the long posts, from which sheave the said rope is returned several times around the shaft of the windlass, D, and is fastened to the outer end of the acting lever, G, the opposite end of which lever is connected by means of an elliptical lever, H, to the power beam, J, which, by the operation of the windlass, D, forces down the moving *fulcrum* and *follower*, K and L, upon the material to be acted upon, M. —When this press is arranged for light pressure, as in the pressing of cheese, &c., a weight suspended upon the end of the acting lever, G, is used instead of the windlass power, as above described.

The proposed advantages of this press, whether employed in heavy or light pressure, is derived from its powerful compound leverage, uniting economy in construction, with facility and simplicity of operation.

This press is well adapted, by a proper variation of its size, to the various purposes of letter pressing, seal and metal stamping, cotton, tobacco, cheese, &c.; for all of which it is manufactured and for sale by FRANCIS S. LANE, No. 279 Bleecker, corner of Barrow street, New-York.

Swift Passage-Boats on Canals, and Steam Carriages on Common Roads.

London, February 6, 1835.

To the Editor of the Railroad Journal:

Sir,—I observe you have published in your Journal of the 12th December last* my letter to you relative to the locomotives plying on the common turnpike—the "City road"—from the neighborhood of the Bank of England to Paddington. Since I addressed you, I have been on a tour to the north, as far as Dundee, in Scotland, and visited most of the railways and manufactories of locomotive engines of the island.

When at Glasgow I visited the "Paisley" and the "Forth and Clyde" canals; and as our country is very much interested in canal navigation, some memoranda relative to the *swift passage boats* on those two canals may not be uninteresting to your readers.

First, of the "Paisley Canal," which has been the longest known, and is still most successful as regards quick travelling. This canal commences at Glasgow, and goes through Paisley (8 miles distant) to Johnston, where it terminates; 12 miles long; no lock in the whole distance. The boats are of iron, of one sixteenth of an inch thick, 70 feet long, 5 ft. 9 in. broad, and weigh 16 cwt. 14 lbs. This is the weight of the iron part alone. The total weight of the boat, including the wood work, (the cabins are of this material,) fixtures, &c. is 33 cwt.; and with 100 passengers, draws 19 inches aft and 18 inches forward. Two horses draw the boat in stages of four miles each; the pair of horses go only 12 miles per diem. There are four boats, which make six journeys each, or twenty-four journeys for the whole, each day. These boats have been running four years. They are generally full. They meet the greatest encouragement, and are very profitable to the proprietors, notwithstanding the fare is so very moderate. The charge is 6 pence, in the after cabin, and 9 pence in the forward, to Paisley, 8 miles; to Johnston, 12 miles, the charge is 9 pence in the after cabin, and 12 pence in the forward cabin. The time usually employed between Glasgow and Paisley is 50 minutes, or 9⅔ miles per hour. This is the narrowest canal I ever saw, generally 30 feet wide and 5 feet deep. The captains of the boats on board of which I travelled, told me that on a narrow canal, such as this, the horses can pull a boat easier, *when travelling rapidly*, than on one of greater section. This, paradoxical as it may appear, is verified by the fact, that on the "Forth and Clyde" canal, which is of 9 feet depth, and 68 feet breadth, the boats, which are of nearly the same dimensions (68 feet long, and 5½ feet broad,) as those on the Paisley canal, are drawn by *three* horses, with 70 passengers on board, and yet travel at about the same velocity as on the narrower and shallower canal. I asked these captains, and also a civil engineer of some eminence, whom I met on board, returning from Johnston, how they could account for this circumstance. Their reply was as follows: On a narrow canal, say 30 or 40 feet wide, the boat passing swiftly through the water, throws the wave against the shore, which being thrown back again against the boat, raises it up, and thus propels it. The wave strikes the boat about two thirds of its length from the bow. But if the canal were much wider, the boat would pass by before the *reflected wave* could reach the boat, and thus give it aid. I give this explanation nearly in the words of these captains, and am responsible only for the correctness of the report of what they told me. I hope this will meet the eye of our distinguished countryman, Gen. C. F. Mercer, Chairman of the Committee of Internal Improvements in the H. of R., who advocates with so much ability *broad* and *deep* canals for transportation, as far more economical than narrow canals. I will now finish what I have to say respecting the fast travelling on the "Forth and Clyde" canal.

This canal, as I have said above, is 68 feet broad by 9 feet deep, and the iron boats are 68 feet long and 5½ feet broad, and when light draw 8 inches water, but with 70 passengers draw 20 inches; this is when in a state of rest,—when in rapid motion they draw less. There are 3 horses employed to each boat, and the passengers who get into the boats at Port Dundas (Glasgow) are set down at Port Hopetown (Edinburgh) in 6¼ hours, a

* See page 358, vol. iv., of Mechanics' Magazine.

distance of 56 miles, or nearly 9 miles per hour. It is necessary to explain to you that the passengers go only a part of the distance on the "Forth and Clyde" canal. They start from Port Dundas and go to Port Downie, (the commencement of the "Union Canal,") a distance of 24½ miles, which includes 4 locks. In the next half mile are *eleven* locks, which are avoided by the passengers being conveyed in omnibuses to boats in the "Union Canal," which carry them on a level of 31 miles to Port Hopetown (Edinburgh). I regret that I did not take a memorandum of the cost of these iron boats, which are light and beautiful vessels, and being fearful of making a mistake I do not quote from memory. On the Lancaster, Carlisle, and Kendal canals, there are rapid boats, but not having travelled by them I do not give you any details. But if any of your readers feel an interest in the above remarks, and wish further information, I can with facility procure it, and will with pleasure communicate it to you.

Since my return from the north I have called on Mr. Hancock, in company with Mr. T., one of the engineers of the Boston and Providence Railway. We found that for the last two months the "Era" and the "Autopsy" have discontinued running, owing to the absence of Mr. Hancock in Ireland, whither he went with the "Era," for the purpose of ascertaining if he could profitably introduce locomotives on the roads of that country. He is now returned to London, and will, I am informed, recommence running these two engines on the metropolitan roads in a few days. Mr. T. and I also went to see Mr. Russell's steam carriage, recently arrived from Glasgow, which will in a few days ply regularly, in conjunction with others of this gentleman's make, between Hyde Park Corner, and Hammersmith (the commencement of the great western road out of London.) This carriage is by far the most tasteful of all the steam carriages I have seen. It is built exactly like the stage coaches of this country, except the dimensions are larger. The whole of the machinery is in the hind boot. The water and the coke are in a *tender*, or separate carriage on two wheels, behind the locomotive. This steam coach will carry six inside passengers sitting *vis-a-vis*, 14 outside on the roof, and six on the tender; total, 26 passengers. From the favorable terms in which I have heard Mr. Russell's engine spoken of, both here and in Glasgow, I feel a great curiosity to ride on it, and I will take advantage of the first opportunity to do so, and will report to you respecting it, as well as others which will no doubt be introduced as the spring advances. You may inquire, why did not Mr. R. remain in Glasgow? I will reply in nearly the words of the gentleman who shewed us this carriage. He said the prejudice against it was great, in consequence of the unfortunate accident by which 12 or 13 passengers were killed or wounded; that it was expedient to come to a distant part of the country. He told us, that for several months this engine plied between Glasgow and Paisley, and performed in a manner to give entire satisfaction; and in consequence, the stage coach proprietors and trustees of the road were alarmed lest this and others would gain so much in public estimation as to become regular coaches. They therefore resolved to drive it off, if possible. This they accomplished by *picking up* the turnpike, and putting fresh metal down in unusual and extraordinary quantities. Notwithstanding the road was made almost impassable, the engine was still continued, and plied regularly several times each day for a whole month, and excited the admiration of all intelligent persons, that it *could* overcome such difficulties. It however was finally injured by being driven for so long a time over a *road so much worse than it was constructed for*, and one of the hind wheels getting into a hole (made by order of the turnpike proprietors), it broke, and the carriage tumbled to the ground; 4 or 5 persons were killed, and 8 or 9 others seriously maimed and wounded. But none of them were hurt from the explosion of the engine, or the escape of steam, but from being thrown with great violence against the rough, new mettled road—the same kind of injury as would be received from a common stage coach breaking one of its wheels when travelling rapidly. I am informed that an action is brought by the owners of the steam carriage, as well as by several of the survivors and the friends of the deceased, killed by this melancholy

event, against the road company, for obstructing the King's highway, and causing the injury and death of a number of persons, besides loss of property. Sanguine hopes are entertained that the guilty will be severely punished.

I forgot to tell you above, that the swell on the two canals, caused by the *quick* passage of the boats, is very inconsiderable.

I am, very respectfully, your obedient servant, GERARD RALSTON.

P. S.—The demand for railway locomotives is very great. I am sending nine to different parts of the United States, and both Mr. Robert Stephenson and Mr. Bury have orders to give them full employment for several months to come.

A Compendium of Civil Architecture, arranged in Questions and Answers, with Notes, embracing History, the Classics, and the Early Arts, &c. By ROBERT BRINDLEY, Architect, Surveyor, &c.

[Concluded from page 213.]

SEVEN ANCIENT WONDERS OF THE WORLD.

1. The brass Colossus of Rhodes, 120 feet high, built by Chares, B. C. 288, occupying 12 years in making. It stood across the harbor of Rhodes 66 years, and was then thrown down by an earthquake. It was bought by a Jew from the Saracens, who loaded 900 camels with the brass.

2. The Pyramids of Egypt. The largest engaged 360,000 workmen 30 years building, and has now stood 3000 years.

3. The Aqueducts of Rome, invented by Appius Claudius, the Censor.

4. The Labyrinth of Psammeticus, on the banks of the Nile, containing, within one continued wall, 1000 houses, and 12 royal palaces, all covered with marble, having only one entrance. The building contained 3000 chambers, and a hall built of marble, adorned with statues of numerous gods.

5. The Pharos of Alexandria, a tower built by order of Ptolemy Philadelphus, in the year 282 B. C. It was erected as a lighthouse, and contained magnificent galleries of marble, a large lantern at the top, the light of which was seen 100 miles distant; mirrors of enormous size were fixed round the galleries, reflecting every thing on the sea. A common tower is erected in its place.

6. The Walls of Babylon, built by order of Semiramis, or Nebuchadnezzar, and finished in one year, by 200,000 men. They were of immense thickness.

7. The Temple of Diana, at Ephesus, completed in the reign of Servius, 6th king of Rome. It was 450 feet long, 200 feet broad, and supported by 126 marble pillars, 70 feet high. The beams and doors were of cedar, the rest of the timber cypress. It was destroyed by fire, B. C. 365.

CELEBRATED ARTISTS OF ANTIQUITY.

Grecian.

ALCAMENES, Statuary, lived 448 years B. C.; distinguished for his statues of Venus and Vulcan.

APELLES, Painter, born at Cos, Ephesus, or Colophon; flourished about 340 years B. C.; patronized by Alexander the Great. He was so attentive to his profession, as never to lose a day without employing his pencil: hence the proverb, "Nulla dies sine linea." His best production was a Venus Anadyomene. He wrote three volumes on Painting. Apelles never put his name to any pictures but three, namely, a Sleeping Venus, Venus Anadyomene, and an Alexander.

APOLLODORUS, Painter, of Athens. Two of his paintings were admired at Pergamus, in the age of Pliny.

CTESIPHON, Architect and Statuary, designed Diana's temple, at Ephesus.

DINOCRATES, Architect, of Macedonia; employed by Alexander in building the city of Alexandria, in Egypt. Dinocrates also restored the temple of Diana at Ephesus.

EUPHRANON, Sculptor and Painter, of Athens, disciple of Aristides, lived 362 years B. C. His principal paintings were the twelve Deities, Battle of Mantinea, and Theseus.

EUTHYCRATES, Sculptor, of Sicyon, son of Lysippus, particularly happy in the proportion of his statues,—those of Hercules, Alexander, and Media, were in general esteem.

LYSIPPUS, Architect and Statuary, of Sicyon, flourished about 325 years B. C., in the age of Alexander the Great. He made no less than 600 statues; some

of which, in the age of Augustus, were bought for their weight in gold.

MYRON, Architect and Statuary, flourished about 442 years B. C.

PAUSIAS, Painter, of Sicyon, lived about 350 years B. C. He was the first who understood how to apply colors to wood or ivory by means of fire.

PHIDIAS, Architect and Statuary, born at Athens, died B. C. 432. He made the statue of Minerva, placed in the Pantheon.

POLYCLETUS, Statuary, of Sicyon, the most skilful artist of his profession amongst the ancients, flourished 232 years B. C. His Body-guard of the King of Persia was a most perfect model, and called the *Rule*. He understood architecture.

PRAXITILES, Sculptor, of Magna Grecia, flourished about 324 years B. C.; chiefly worked on Parian marble. The most famous of his pictures was a Cupid, which he gave to Phryne. He also made two statues of Venus for the inhabitants of Cos.

SCOPAS, Architect and Sculptor, of Ephesus, designed the mausoleum which Artimesia raised to her husband. One of his statues of Venus was among the antiquities with which Rome was adorned. Scopas lived about 450 years B. C.

Roman.

CHARES, Sculptor, of Lindus, flourished four centuries B. C.; made the Colossus of Rhodes. He was twelve years engaged in this Herculean task.

M. VITRUVIUS POLLIO, Architect, born at Formæ, flourished in the age of Augustus, about A. D. 44, and is only known by his writings, which were dedicated to Augustus; the best edition is De Laet. Amst.: 1649.

And here the pen of the Historian and Biographer drops. When the standard of "the great mistress of the world" waved no longer upon her devoted walls, and, human grandeur failing, dipt the western horizon, history and art also succumbed to the hand of barbaric rapine and unsparing destruction. For the space of nearly 1000 years, no sun of science and art ever dawned. Every beam was hidden by those clouds of Gothic darkness which hung so heavily around the ravaged empire. But at last the storm gave way: art again shed a benignant smile over the desolated garden of Europe, and reared her sons in pleasing succession; and although at intervals a MIGHTIER HAND has subsequently driven the ploughshare of destruction, shook the foundation of cities and towns, and enwrapt them and their inhabitants in the depths of awful earthquake, yet sparingly has been the deed, and fair ITALIA's renown is yet perpetuated through the wide continent, extending to Britain's shores, where record bears testimony of names eminent for their productions; and emulation fans the flame that may ultimately illumine, in like meridian splendor, divested of its fatality, this

"——our own, our native land."

Remarks on the Protection of Copper Sheathing upon Ships' Bottoms. By G. G. BOMPAS.

It is a well known fact, that when dissimilar metals are placed in contact in a saline, or acid, solution, such as sea-water, they have an electric action upon each other, becoming on the one part positively, and on the other negatively, electrified; the effect of which is destructive of the positive metal. This has been too little regarded in the sheathing of vessels.*

The various metals and alloys employed in the building and sheathing of a ship almost always stand in this electric relation of positive and negative to each other; and if, as is generally the case, the copper sheathing is the positive metal, it will be destroyed with a rapidity proportionate to the degree in which the electric action is excited.

The sheathing nails in common use are prepared of metals in very various proportions, regard being chiefly had to their color and tenacity; and an examination of several specimens has proved them to

* At this very time, an experiment is making in France, by sheathing one half of a ship's bottom with *cuivre bronze*, a metal negative to copper, and the other half with copper, the metals being in contact. It is easy to foresee that the positive metal, the copper, will lose more by corrosion than the negative metal, and thus give an apparent, but deceptive, advantage to the *cuivre bronze*. In one such an experiment already tried, the results of which have been published, the copper had, in fact, sustained more than what would be its *average* loss, when not connected with the *cuivre bronze*. In all experiments on new metallic sheathings, there should be no *metallic* communication between the metal to be tried and any other.

be as various in their electric relations with copper, as in their composition. They are generally negative to the copper, and consequently promote its corrosion. Numerous experiments have proved that the galvanic action, induced by the contact of such metals, is necessarily destructive of the positive metal; and they satisfactorily explain the irregular duration, and frequently rapid destruction, of the copper sheathing, which is often erroneously ascribed solely to impurity in the copper. If the sheathing of vessels returned from a voyage be examined, the hollows made by the heads of the nails will generally be found filled with crystals of the salts of copper, and the copper itself is often completely corroded through. In an experiment, where copper obtained from H. M.'s dock-yard was employed, and to avoid all error, each sheet was divided in half, one half being nailed to a board with pure copper nails, and the other with different samples of the nails in actual use at different dock-yards; after ten weeks' immersion in the sea at Portsmouth harbor, one half-sheet had lost two hundred and ninety-three grains more than its fellow, a second had lost thirty-two grains more than its fellow, and a third had lost twenty grains more than its fellow half-sheet: but one with nails prepared on the principles recommended in this paper, had lost thirty-four grains *less* than its fellow half-sheet. It is fair to presume that, if sheathing nails similar to the samples had been used with the same copper on a ship, the duration of the sheathing would have been in somewhat the same proportion.

Copper possesses great advantages over the various alloys introduced for sheathing, from its flexibility and toughness, by which it can be applied with facility, and yields to the strain of the vessel, while, by the slow solution of its surface, it very considerably diminishes the foulness from attachment of marine vegetables and animals. The chief objections to it are, its expense—the liability to corrosion, and consequent irregularity and uncertainty of its duration—and its being too soft to be used for nails, without an admixture of such other metals as generally render them negative to, and destructive of, the copper. But it is equally an objection to the other metals and alloys, that they cannot at the same time be sufficiently soft for sheathing, and yet hard enough to drive as nails. These disadvantages may, however, be almost entirely obviated by the plan now proposed.

First, by the use of sheathing nails that shall be compounded of such metals, in such proportions, as are known not to exercise any destructive agency on the sheathing, but, on the contrary, have a tendency to preserve it.

Secondly, by attaching to the sheathing a metal positive to it, which, while itself in the process of being destroyed, shall preserve the sheathing from corrosion. For it is evident that if, when several metals are placed in communication with each other, the most positive will be destroyed, and the others preserved, the application to the sheathing of a more positive metal, or compound, will thus be a protection to it. It is also obvious that the positive metal may easily be so applied, as that its destruction shall in no degree impair the strength of the vessel, or render necessary any general or expensive repairs.

Upon this principle, (the correctness of which he fully established,) Sir Humphry Davy applied masses of zinc, or of iron, of different proportionate surfaces, to the copper to be protected. The result was, that a very strong electric action was excited, and the corrosion and waste of the copper almost entirely prevented. But he found the electric energy so intense, if the protecting metal was in a large proportion, that the copper, by the decomposition of the sea-water, very speedily became covered with an earthy accretion, to which animals and plants adhered; and the sheathing became so foul as materially to impede the ship's progress. On the other hand, if a small proportion of the protecting metal were employed, it was destroyed so rapidly, that the duration of the protection was too short to be of any value. These difficulties induced him to abandon his experiments.

The difficulties which frustrated the attempts of that eminent philosopher have been completely removed by the employment of a compound metal, which differs much less from the copper, in its electric relation, than either iron or zinc. By the use of such a compound, in which the proportions of metals may be varied as

required, a larger protecting mass may be employed, a more diffused and uniform electric action produced over the whole surface of the sheathing, and just that protection afforded which shall preserve it from corrosion, without causing foulness.

The protecting metal should be attached upon the sheathing in a longitudinal belt, or band, a few inches wide, according to the size of the vessel, from stem to stern, about the light water line; and in large vessels, an additional band should be attached to the keel. Being in the direction of the passage of the vessel through the water, it will not impede her sailing; if destroyed, it will not injure the ship; and, when necessary, it can be easily removed, and renewed, without disturbing the sheathing.

After repeated and most satisfactory experiments at Portsmouth, under the inspection of the officers of H. M.'s dockyard, the Lords Commissioners of the Admiralty were pleased to direct that the sheathing of H. M.'s schooner Fair Rosamond should be protected on this plan, preparatory to her sailing for the coast of Africa, where she is now stationed. She was commissioned in May, 1833, and sailed first to Oporto, and afterwards to Africa. No official report has yet been received; but in November, 1833, her copper is stated, on undoubted authority, to have been clean and bright; and by subsequent accounts, it is proved to have continued so, up to the end of March, 1834.

On the whole, it has been proved that, by the adoption of the sheathing nails and protectors, the duration of the copper will be very much extended, and rendered comparatively certain; that such instances of its rapid destruction, as now so frequently occur, will be entirely prevented; and that, so far from the protectors being the cause of foulness, the sheathing will be preserved much more clean and bright than under ordinary circumstances.

Iron, and other metals, or alloys, exposed to sea-water, or acids, whether as iron cables, sheathing, or any other form, may be preserved from rust, or corrosion, on the same principle.—[London Journal.]

[For the Mechanics' Magazine.]

To find how large a square timber can be made of a round log, the diameter being given.

Rule. The square root of half the square of the diameter of the log is equal to one side of a square timber, as large as can be made.

Examples. Suppose a log 17 inches diameter, how large will it square?

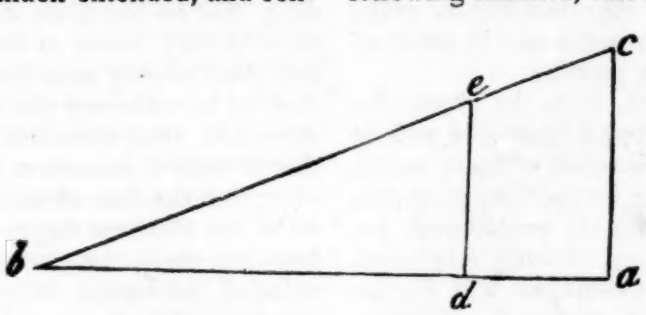
$17^2 \div 2 = 12$ inches, equal to one side.

How large a log is required to make a stick of timber 6 by 8 inches square?

$\sqrt{6^2+8^2} = 10$ inches.

To eight-square a stick of timber.

There are various ways to eight-square timber. I will give one or two ways that are the most convenient and simple. Suppose a stick of timber, 12 inches square, is to be eight-squared: half the diagonal line from corner to corner, set on from the corners each way, will give the eight-square very near; but a more perfect rule is to make a scale, in the following manner, viz.: Draw a line, *a b*,



twelve inches or twenty-four inches long; on the end, at *a*, raise a perpendicular, *a c*, five inches high, if *a b* is 12 inches; but if *a b* is 24 inches, then *a c* should be 10 inches; draw the line, *b c*; set off the bigness of the timber to be eight-squared from *b* towards *a*, and draw a perpendicular, as *d e*; then *d e* is the

bigness of one square, which must be set off, half of it each way from a centre line.

Example. Suppose a stick of timber eight inches square is to be eight-squared: set off eight inches, from *b* to *d*; draw the perpendicular, *d e*; take half of *d e* in the dividers, and set off each way from the centre. S. A.

[From the London Repertory of Arts.]

Specification of the Patent granted to RICHARD WALKER, *of Birmingham, in the County of Warwick, Manufacturer, for an Improvement in Wadding for Fire-Arms.*—Sealed June 26, 1834.

To all to whom these presents shall come, &c. &c.—Now know ye, that in compliance with the said proviso, I, the said Richard Walker, do hereby declare the nature of my invention, and the manner in which the same is to be performed, are fully described and ascertained in and by the following description thereof, reference being had to the drawing in the margin hereof, and to the figures and letters marked thereon: that is to say, my invention consists in the application of metallic discs (having suitable apertures for the passage of air) to the purpose of waddings for fowling pieces and such like fire-arms, as will be fully described hereafter.

Fig. 1. Fig. 2. Fig. 3.

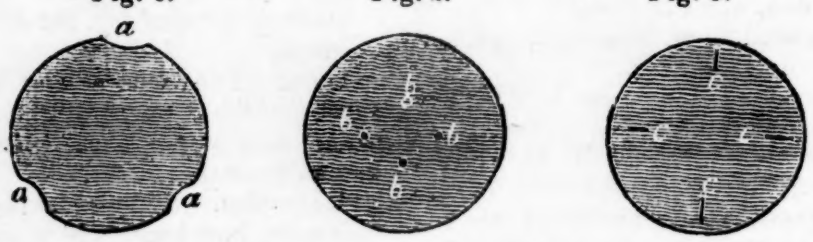


Fig. 1 represents a circular disc of metal, which is made to the size required for the bore of the intended fowling-piece, and in such manner as to touch the barrel all round except at the parts, *a*, *a*, which are apertures or openings, through which the air in the barrel passes, in the act of ramming down the wadding.

Fig. 2 shows another metallic wadding, having perforations, *b*, *b*, in place of the parts, *a*, *a*, cut out at the outer edges in fig. 1: and

Fig. 3 represents another wadding, having short slits, *c*, *c*, for the passage of the air. It will be evident, that the shape or form of the apertures will not be material, care being observed not to make them of such dimensions as will allow of the passage of the powder.

It will be evident, from the above description, that various advantages will be derived in the application of these metallic discs as wadding for sporting purposes, in place of the ordinary pasteboard, paper, or other wadding formerly employed. Amongst other advantages will be the close contact of the shot to the powder, and the consequent compactness of the charge. And it will be desirable to remark, that in ramming down such metallic wadding, it will materially tend to cleanse the interior of the barrel after each discharge.

Having thus described the nature of my invention, I would remark, that I usually form such discs as above described by means of the ordinary fly-press; and I usually cut them from thin sheets or plates of brass, from one hundredth to one hundred and twentieth of an inch in thickness, such brass being tinned. Although I prefer brass, I do not confine myself to that metal, but intend to avail myself of other metals, or compounds of metals, suitable for the purpose, care being observed that in whatever metal chosen for the purpose of making such wadding, that its hardness shall be such that the ordinary worm or screw on the ramrod shall readily pass through when it is desired to withdraw the charge; and it is desirable, that whatever metal is used, that it should possess a degree of elasticity, that the disc or wadding being formed in the slightest degree larger than the bore, it shall, by pressing against the sides of the barrel, offer sufficient resistance to retain it securely to the place to which it is rammed: and it will be desirable further to remark, that lead should not be used, owing to its want of such degree of elasticity, but more particularly as it

would add to that prejudicial effect usually produced by the shot in discharging a fowling-piece, termed "leading," and which my improved wadding has a tendency to remove.

Having now described the nature of my invention and the manner of carrying the same into effect, I would have it understood, that I do hereby expressly confine my claim of invention to the application of metallic discs (having suitable apertures for the passage of air) to the purpose of wadding for fowling pieces, and such like fire-arms, as above described.—In witness whereof, &c.

Enrolled August 22, 1834.

Undulating Railways.

To the Editor of the Railroad Journal:

Dear Sir—Messrs. Badnall & Stephenson, in their views respecting Undulating Railroads, are both right and both wrong. Mr. Badnall's experiments prove, that in locating Railroads in this country, where they must necessarily be undulating, an effect of power may be had not differing materially from the effect had upon level railroads; and it becomes the duty of engineers, to whom this subject more particularly belongs, to give *particular* attention to it.—Mr. Stephenson's views are correct in favor of level railroads; but it is out of the question to have them level for any considerable length in this country, or any other. We must then consider the results of Mr. Badnall's experiments as highly useful and important, inasmuch as they demonstrate that the useful effect upon a railroad over an undulating country may be nearly, if not quite, equal to the effect if the road were level. I belong to the craft whose duty it is to make these subjects their study, and if you do not greet me too roughly, may remind you occasionally of,

Most respectfully, your

FRIEND.

Washington, D. C., March 30, 1835.

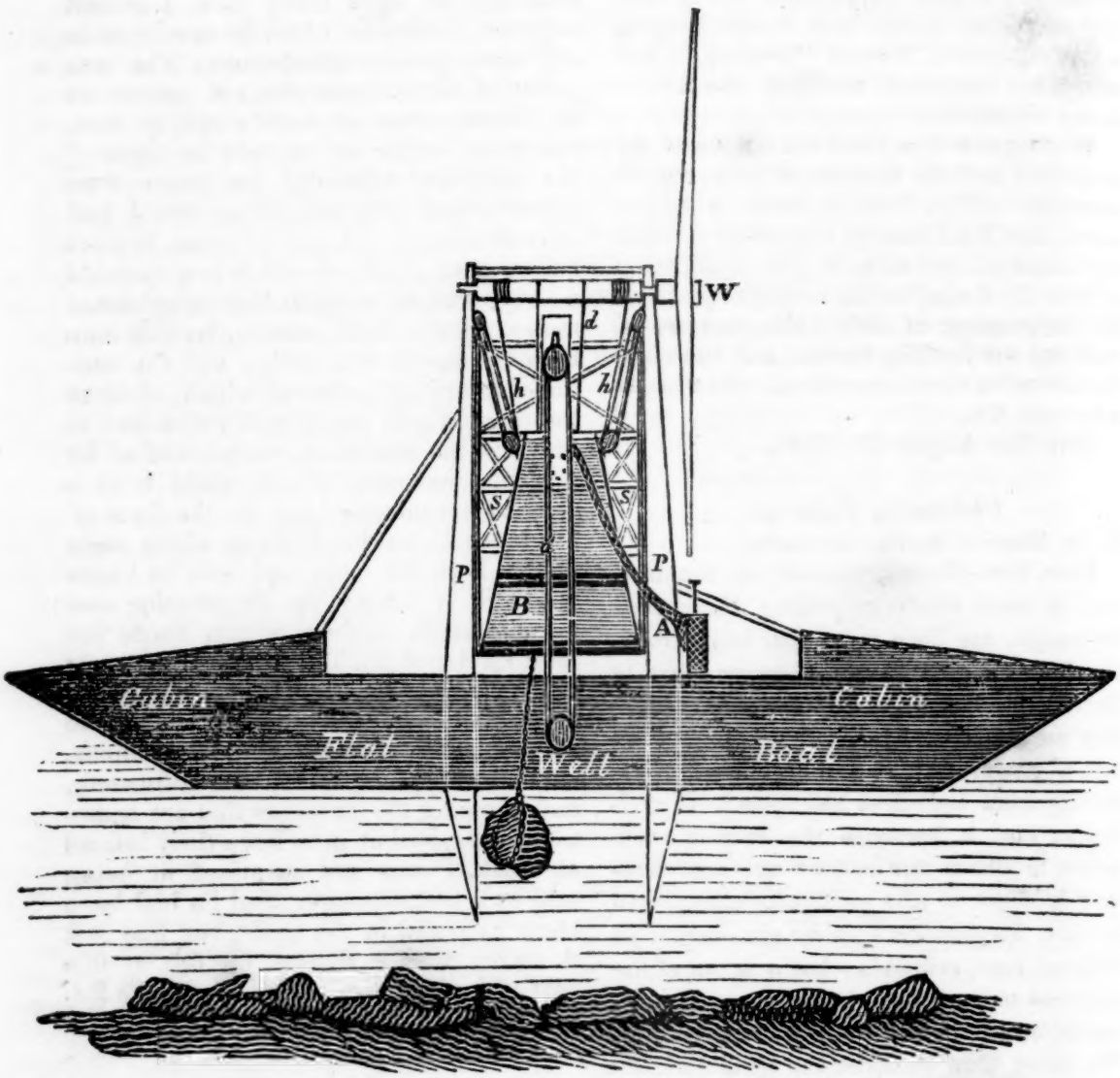
PIN HEADING. — The process of pin-heading, three establishments for which I visited, is carried on in the following way: A large room is filled with small tables, at each of which sit four children, about thirty or forty together in a room, and certainly of ages lower than I should suppose it possible could be employed in any other gainful occupation. The majority of those I saw did not appear to be above seven or eight; and, in fact, the scene, as far as regards the ages of the children, reminded me more of an infant school than any thing else I had ever witnessed. A sort of frame is fixed before each child, on which is suspended a heavy weight, which is kept in perpetual motion by the child pressing its foot on a treadle beneath the table; and the continual thumping noise of which, close to the infant's ear, seems well calculated to produce the ear-ache, complained of by several witnesses. Each child is in a position continually bent in the form of the letter C, its head being about eight inches from the table, and both its hands engaged in taking up the shanks, and putting heads on them, which heads are then tightened by blows from the weight suspended before it. On the whole, the employment of pin-heading seemed to me the most irksome and monotonous, without exception, I had ever witnessed; and knowing the cruelties that are sometimes practised at it, to keep their infants at work, I was not surprised at being told by a manufacturer, that he had been once engaged in the trade, but had left it, owing to the disgust he felt at this part of the business.—[Mr. Tuffnell's Report, Factory Commission.]

To the Editor of the Mechanics' Magazine:

SIR,—I send you the following description of a Diving Bell of my contrivance, which I have employed in improving St. Mark's Harbor, under the directions of the U. S. Engineer Department, to which I have communicated the same. This machine has answered an excellent purpose, doing better than at first I had calculated upon.

I think, further, that it may be advantageously used for removing sunken rocks from the rapids of rivers, and clearing a boatable channel where the water is too strong and deep for workmen otherwise to effect any thing useful; of which there are numerous places where such improvements are much wanted on the rivers throughout the country.

If you think this worth a place in your



Magazine, you are at perfect liberty to insert it. Respectfully yours,

GEO. W. LONG,
Lt. U. S. A., Engineer duty.
Tallahassee, Fa., Feb. 28, 1835.

—

Plan of a Diving Bell, used in clearing Rock from the Channel at the Devil's Elbow, St. Mark's Harbor—calculated to work at the depth of nine feet.

This machine has been in operation from September, 1834, to March, 1835, with the full desired effect.

The bell, B, as seen by the figure, is set in a frame, *s s*, which slides vertically in the posts, P P, and is worked by the wheel and axle above it, and the hoisting pulleys, *h h*, and the downward ones, *d d*. The wheel is turned one way to raise the bell and load of rock, and the opposite to sink it again. It is furnished with two glass lights in the head, which makes it as light within as day, and an air-pump, A, to supply fresh air, if needed. W, the wheel and axle.

The buoyancy of the bell, and the power of the wheel and axle and pulleys, are sufficient to tear up any rock that can be got hold of; and for heavy broken rocks, can be made to remove them almost with the same facility as from a dry quarry. The stone at the Elbow had been previously blasted and broken up, by sinking canisters of about 4 lbs. of powder 5 or 6 feet into the rock, and firing them.

The operation of the bell is carried on with seven hands, inclusive of overseer and cook. It can be run up and down in the space of 30 or 40 seconds.

[From the London Mechanics' Magazine.]

The Undulating Railway—Mr. Badnall in Explanation.

Dear Sir: Your readers might naturally expect that I should have taken a much earlier opportunity, either of publishing the particulars of those experiments to which I so urgently invited their attention some time ago, or that I should have given some satisfactory explanation of my motive for withholding them. I am not, however, without a hope that this letter will prove a sufficient vindication of my conduct against any charge of neglect or wilful delay.

In my letter of the 20th August last (1834,) I stated that the Whiston Branch Railway was completed, but that our experiments were unavoidably delayed by the refusal of the Directors of the Liverpool and Manchester Railway to accommodate us by the loan of a suitable locomotive engine. At the same time, I intimated that, under such circumstances, I had no other resource than to endeavor to obtain an engine elsewhere, either on loan or hire.

With this view I made every necessary inquiry; but the only engine which I could hear of as being disengaged was the Manchester, which was built by Messrs. Galloway, Bowman and Glasgow; and though capable of dragging a considerable load, she was, from her particular construction, by no means adapted to the safe attainment of that velocity which could alone determine, on the Whiston line, the comparative superiority of an undulating or horizontal railway. I say upon the Whiston line, because the dip of the undulation was greater than I should ever recommend in practice; which may be judged of from the fact, that a loaded waggon, descending from the colliery by gravity alone, attained, after traversing about 500 yards, a velocity of upwards of 30 miles per hour.

Perceiving, however, that I had little, if any other, chance of trying immediate experiments, I consulted my partner, Mr. R. Stephenson, sen., on the subject, who, from being well acquainted with the capabilities of the engine, strongly objected to her being employed for the purpose in question, it being his opinion that, although a very powerful engine, when in good repair, the Manchester could not be trusted at those velocities which, upon the Whiston undulation, it would be necessary to attain. Mr. G. Stephenson was also of a similar opinion.

Thus situated, I resolved on making a second application to the Directors of the Liverpool and Manchester Railway, offering, at the same time, a guarantee for payment of any damage which the engine might sustain, and explaining the difficulty in which I was placed, by having publicly announced the trial of my experiments; which announcement I was induced to make in consequence of a verbal communication which I previously had with Mr. Booth, and from which I had formed, it appears, erroneously, an opinion that, if a *guarantee were* given, there would be no longer an objection to the loan of an engine being granted me. To this second application I received the following reply:

"Railroad Office, Oct. 13, 1834.

"Dear Sir: I submitted to the Board your renewed application for the loan of a locomotive engine, for your proposed experiments on the Whiston Branch Railway, and am required to inform you that the Directors regret they cannot comply with your request. They gave the matter due consideration previous to their former decision, and they do not see reason to alter the determination they then came to. I am, dear Sir, yours most obediently,

"H. T. Booth.

"Richard Badnall, Esq."

Under these circumstances, and finding how impossible it was for me to obtain a suitable engine, and feeling how deeply I had committed myself in your pages, by a declaration that the period was arrived when the whole question should be determined without further delay, I was resolved to adopt the only means which were left me of even partially fulfilling my pledge to the public. On the 21st October, I therefore called on Messrs. Galloway and Co., and solicited the loan of the Manchester engine for a few experiments, under the promise that the maximum velocity attained should not exceed from 20 to 25 miles per hour. With a liberality for which I feel greatly indebted, Messrs. G. and Co. granted my request, merely requiring a guarantee that I would return it in as good condition as I received it. On examining the state of the engine, it was found that the pistons required repacking; but as we could not expect to come to any very decided result, (the velocity being limited,) it was thought unnecessary to make any alteration for a first trial. On the 24th October, Mr. Robert Stephenson, sen., and Mr. Gill, accompanied me, therefore, to Whiston; and the Railway Directors having accommodated us with empty waggons, we proceeded, after loading them with coal, to the trial of such experiments as we deemed compatible with safety, and likely to produce some data, whereon an opinion, pro. or con., could be formed.

It is necessary that I should here state, that the Whiston branch line was complet-

ed by Mr. M'Kenzie, under contract. That gentleman had previously given me a section, and although, upon that section, the summit levels were, no doubt, accurately defined, no intermediate levels had been denoted, either on the section or by stakes, on the ground itself; our only course, therefore, was to start from such parts of the descending line from the colliery, as would prevent our attaining a dangerous velocity, and to ascertain how far the train would rise on the opposite ascent; marking the starting and resting points, until future levels could be taken. Had the inclinations been regular, this precaution would have been unnecessary, as the measurement of the distances would, in such case, have determined the elevations. But the Whiston line forming one extensive undulation, varying according to the surface of the land, no criterion could be formed from such calculation.

An accident, which some time ago occurred to the Manchester engine, which left the rails, when descending the Sutton inclined plane, had unfortunately given her the character of an unsafe engine at high velocities; and it was evident that, on the present occasion, both the engineer and fireman were afraid of her. We, however, made eight experiments; Mr. Stephenson, myself, or Mr. Gill, accompanying the engine-man on each occasion. Our load was 80 tons; which, considering the condition of the engine, was an ample one, as she was proved to be only capable of drawing on that day about 15 tons up an inclination of 1 in 84, her steam being at from 40 to 50 lbs. on the inch pressure, though partially escaping between the piston and cylinder.

By these experiments, we were enabled to prove one very satisfactory circumstance—which was, that, notwithstanding the many disadvantages under which we labored, the train invariably rose to a higher summit than that from which she had previously started. For instance, in the first experiment, the train started from a given point, which was carefully denoted, and rose to a higher point on the opposite ascent, which was also denoted; the total distance being 760 yards—time, 2′ 35″. The power then being reversed, the train rose 34 yards higher than it had originally started from; again being reversed, the train rose 64 yards higher than on the first experiment; total distance 862¼ yards, time 2′ 26″. The power being again reversed, the train rose 38 yards higher than before—total distance 900 yards; when again reversed, the train rose 171 yards higher than before—total distance 1071 yards; and on the next occasion the total distance was 1167 yards.

On the 7th trial, no accurate result could be deduced, as some of the brakes were on the waggon wheels.

On the 8th experiment, the steam was brought down to 10 lbs. upon the inch; and I have every reason to believe, that when I am enabled to transmit to you a precise statement of the level from which it started and at which it rested, it will be found that the 80 tons were conveyed at that low pressure, very nearly, if not quite, from summit to summit.

Your readers will, I fear, be disappointed, and by no means satisfied with the rude statement which I now feel it imperative upon me to publish; but until I have a better opportunity of deciding the full merits of the question, I can only put them in possession of facts as they really occurred—this I have done myself. In justice to myself, however, and to the cause which I have conscientiously advocated, and still continue to advocate, I ask them, what could I have done more? or what, under existing circumstances, can I do? All men of science must, I am persuaded, sympathise in my regret, that experiments of such a nature should be delayed, when such delay could be so easily avoided; and with regard to any chance of a satisfactory conclusion being come to, by employing the Manchester engine, I need only refer to Messrs. Galloway & Co. themselves, who, I am sure, will bear testimony to her being in every point of view unsuitable to the purpose. She is, as before observed, an engine capable of drawing heavy loads at moderate velocities, but her many moving parts and general construction render her altogether unfit for the trial in question. It was my wish to have sent with this letter a correct section of the Whitson branch, with the exact distances denoted thereon, which the train traversed at our recent experiments; but severe indisposition, which has, since the end of October, with the exception of a few days, confined me to the house, has prevented my paying that attention to the subject which I should otherwise have done. Wishing, however, to have an impartial survey of the line made, I wrote to Mr. Hall, of Warrington, begging him to prepare the necessary sections, showing the various levels, &c.; but he has not yet been able to undertake it, owing to his time being entirely occupied in completing a survey of the Grand Junction line, to deposit for Parliament: when the section alluded to is completed, I will forward you a copy of it. As a proof of the unfitness of the Manchester engine, for the trial of experiments on the Whitson line, I need only remark, that over a great portion of each undulation, her power was not only

ineffectual, but she was almost an incumbrance, owing to the loaded waggons attaining, by gravity, a greater velocity than she could effectually command in advance of them. This will easily be understood by those who consider the difference in the friction of a railway waggon, and a locomotive engine of her description. It also shows, that upon deep undulations, such as the Whitson line (where we have a fall of more than 30 feet in 500 yards), none but engines capable of sustaining an excess of speed above that which is produced by gravity, can be employed with *full effect*. Such was my view when, in allusion to the Whitson line (in a former number), I said, "*the full effect of practical experiment must depend upon the momentum acquired by the combined forces of gravity and steam being safely and effectually maintained down the descending line of each undulation.*" For the same reason, also, I have before mentioned that, for general practical purposes, a dip of about 15 feet in a curve of 1,000 to 1,200 yards, would be the proportion I should most strongly recommend: though exceptions might, of course, be advantageously made, where the nature of the ground required it—especially in passing under or over cross-roads, canals, &c., or where the inclined planes would not be so deep or so extensive as to produce a dangerous velocity without the employment of the brakes—considering, as I do, that velocity on railways is always dangerous when the engine (her full power being employed) is not able to keep up a dragging influence on the succeeding carriages, or, if behind the train, a propelling influence on the carriages in advance.

So convinced did I feel that no further impediment would be thrown in the way of a full and impartial trial of the undulating railway theory at Whiston, that at the meeting of the British Association at Edinburgh, in September last, I as publicly announced my intention of immediately bringing the question to issue, as I had previously done in your pages. I hope, therefore, I shall not be accused of any disrespect to your readers, to yourself, or to the public at large, for a breach of engagement which it has been entirely out of my power, for the present, to obviate. I am, Sir,

Yours most respectfully,

RICH. BADNALL.

Farm-hill, near Douglas, Isle-of-Man,
Dec. 31, 1834.

DR. CHURCH.—The attention of many persons was attracted on Saturday to Dr. Church's beautiful steam-engine, which was running on the Covington road. The ground run over was six miles out and six home; and, notwithstanding the roads were in the heaviest possible state, in one of the trips four milestones (i. e. three miles) were passed in nine minutes; and two milestones were passed in the extraordinary short space of two minutes and a half.—[Birmingham Gazette.]

The following remarks of Mr. Green apply with equal force to many other branches of mechanics in this country. We certainly have the talents and the enterprize, and only want patronage from those who now go abroad for their articles.

[From the American Journal of Science and Arts.]

On the construction of the Barometer, and other Philosophical Instruments, in this country. By JAMES GREEN, Philosophical Instrument Maker in Baltimore.

To Professor Silliman:

Dear Sir,—Early after the publication of No. 1, Vol. XXVII., of your very valuable Journal, my attention was directed to an article on the construction of the Barometer; and, although interested in all improvements of the means of making philosophical observations, I felt particularly so in the present instance, from having received an order on account of the public service to construct a Barometer that would furnish accurate indications of atmospheric pressure, on any plan which my experience in this branch of manufacture might approve.

In perusing the article, I was particularly attracted by the coincidence which existed in the construction of some parts of Mr. Durant's instrument, and a modification of Gay Lussac's Barometer by M. Bunten, a favorable report of which was read before the French Institute, by Messrs. Savart and Arago, and which subsequently received a favorable notice from Baron Humboldt, who, after having used the instrument during a travel through Germany of several months, testified to its efficiency in preventing the admission of air into the mercurial column. The *Globe Portable Barometer* of Mr. Durant seems to present all the advantages derivable from that arrangement, with some additional securities. However, I must freely confess that the gratification which a Philosophical In-

strument Maker might be presumed to derive from such a circumstance, was in some measure diminished by discovering the writer to be under the impression that there existed an indifference to all efforts at the perfection of so important an instrument as the Barometer, on the part of the manufacturer, who, I hope, may be often found both "willing and able" to resort to all the precautionary means necessary to insure as perfect an instrument as practicable, when such an instrument is wanted. In so far as the accuracy of the instrument may depend upon the boiling of the mercury in his tube, it is a very common thing with him to take the "patient care" required in this operation. Indeed, it has been my uniform practice to observe this precaution in all instances where such accuracy was desirable, and also to use mercury that had been redistilled.

I have been induced to state these facts, because, from the tone of the article alluded to, an individual who might desire a perfect instrument would be brought naturally to the inference, that in as much as good Barometers are constantly being made somewhere, if he cannot obtain one here, he can do so abroad.

I do not suppose, however, that either yourself or the writer would wish to increase the already unfavorable prepossession which to some extent exists, to the prejudice of the instrument makers of this country. They labor, it is true, under disadvantages in the manufacture of some parts of a philosophical apparatus, which are not experienced elsewhere. But the Barometer does not belong to this class. In its construction nothing is wanting but a proper knowledge of the principles it involves, and that facility of manipulation which experience usually yields.

On visiting London and Paris in the years 1830 and '31, for the purpose of availing myself of the great advantages which those cities afford for improvement in mechanical skill, as well as the collation of philosophical facts, and while there, being engaged in some experimental observations on the construction of the Pyrometer, I had frequent intercourse with one of the most deservedly distinguished instrument makers of the former city, who I found entertained a more favorable opinion of the extent of the demand for good instruments in the United States than my experience authorized; that opinion doubtless arises from the frequent orders he received to furnish such for this country. It may be proper to remark, that many of these were of a character that could have been readily furnished here, had there existed that confidence which many of our own workmen are entitled to receive.

Conceding, however, the imperfections of the ordinarily manufactured Barometer, I cannot join with the writer in attributing to this circumstance mainly the existing neglect of so useful an instrument, when used as a weather glass; but would rather refer it to the *lengthened* series of observations it is necessary to make in every particular place, before such satisfactory general rules can be deduced as will enable us to infer from specific movements in the barometric column definite changes of weather, few persons being found willing to make periodically precise observations.

In conclusion, I may be allowed to remark, that in view of the advancement of meteorological science, the want of uniformity both in the principle and construction of the various instruments used throughout this extensive country, in order to furnish correct meteorological tables, is certainly to be regretted, and any plan that could be suggested, which might obviate this difficulty, by establishing such uniformity, would doubtless materially enhance the value of these records in promoting the advancement of Natural Science.

Baltimore, Oct. 10th, 1834.

Effects of Lime on Fish. — As a barge laden with lime was proceeding up the Ouse, from Lewes, from some cause or other, it sunk near Barcombe. The effect on the fish in the river was instantly manifested. Hundreds rose to the surface, and a great number were taken by hand. Pike were seen darting about in great agony; and most of the finny tribe within a mile of the spot where the accident occurred were rendered blind, from the burning nature of the lime. It is calculated that some thousands of fish perished. — [Scientific Tracts.]

[From the American Journal of Science and Arts.]

A live Snake suspended by Spiders.

Batavia, N. Y., Sept. 30, 1835.

Sir,—In the "Spirit of the Times" of this village, of the date of Aug. 26, 1834, I published over the signature of "A Witness" an account of a *snake* found suspended by spiders' web, by the tail, in the wine cellar of a gentleman in this village.

A gentleman who also saw and examined the phenomenon, promised to send you a drawing and account of it. Whether he has done so or not, I do not know. And as the story has been treated as a fable by some of the papers, I send you enclosed the account above mentioned, and a correct drawing, (though rough and done in haste,) made by James Milnor, Jr. Esq., a clerk in the Holland Company Land Office.

The gentleman in whose wine cellar the snake was found, is the Hon. David E. Evans, agent of the Holland Land Company, who requests me to forward to you the drawing and account, which he pronounces to be accurate.

Mr. Evans, Mr. Milnor, Mr. Mix, Doct. Van Tuyl, and a great number of other gentlemen, examined this subject *critically* on several different days, while the snake was yet alive, and all concur in the accuracy of the account.

I hope you will procure a correct engraved cut of the drawing, and publish it with the account in your journal. And if you do, you are at liberty to use all the names mentioned in this letter, or to publish it at length, if you think proper.

Most respectfully, your ob't servant,

S. Cummings.*

The following is the account alluded to in the above letter:

On the evening of the 13th inst., a gentleman in this village found in his wine cellar a *live Striped Snake*, nine inches long, suspended between two shelves, by the tail, by spiders' web. The snake hung so that his head could not reach the shelf below him, by about an inch; and several large spiders were then upon him, sucking his juices. The shelves were about two feet apart; and the lower one was just below the bottom of a cellar window, through which the snake probably passed into it. From the shelf above it, there was a web in the shape of an inverted cone, eight or ten inches in diameter at the top, and concentrated to a focus, about six or eight inches from the under side of this shelf. From this focus, there was a strong cord made of the multiplied threads of the spiders' web, apparently as large as common sewing silk; and by this cord the snake was suspended.

Upon a critical examination through a magnifying glass, the following curious facts appeared: The mouth of the snake was fast tied up, by a great number of threads, wound around it, so tight that he could not run out his tongue. His tail was tied in a knot, so as to leave a small loop, or ring, through which the cord was fastened; and the end of the tail, above this loop, to the length of something over half an inch, was lashed fast to the cord, to keep it from slipping. As the snake hung, the length of the cord, from his tail, to the focus to which it was fastened, was about six inches; and a little above the tail, there was observed a round ball, about the size of a pea. Upon inspection, this appeared to be a green fly, around which the cord had been wound as

* We understand that Mr. Cummings is first Judge of the Court of Common Pleas in this county, and also Postmaster of Batavia.

the windlass, with which the snake had been hauled up; and a great number of threads were fastened to the cord above, and to the rolling side of this ball, to keep it from unwinding, and letting the snake down. The cord, therefore, must have been extended from the focus of the web, to the shelf below, where the snake was lying when first captured; and being made fast to the loop in his tail, the fly was carried and fastened about midway, to the side of the cord. And then, by rolling this fly over and over, it wound the cord around it, both from above and below, until the snake was raised to the proper height, and then was fastened, as before mentioned.

In this situation the suffering snake hung, alive, and furnished a continued feast for several large spiders, until Saturday forenoon, the 16th, when some persons, by playing with him, broke the web above the focus, so as to let part of his body rest upon the shelf below. In this situation he lingered; the spiders taking no notice of him, until Thursday last, eight days after he was discovered; when some large ants were found devouring his dead body.

A Witness.

The inquiry has been made, whether the snake might not have fallen by accident into a web previously made, and thus have become inextricably entangled.—*Ed.*

Science of Projectiles.—This is the name for that branch of mechanical philosophy which treats of the motion of bodies projected from the surface of this earth, and influenced by the action of terrestrial gravity.

Any body projected from the mouth of a cannon must describe a conic section, having the centre of the earth in one focus, and it will describe round that focus areas proportional to the times. And it might easily be demonstrated, that if a velocity of projection were to exceed 36,700 feet in a second, the body, (if not resisted by the air,) would describe a hyperbola; if it were just 36,700, it would describe a parabola; and if less than this, it would describe an ellipsis. If projected directly upwards, in the first case, it would never return, but proceed forever, its velocity continually diminishing, but never becoming less than an assignable portion of the excess of the initial velocity above 36,700 feet in a second; in the second case, it would never return, its velocity would diminish without being extinguished; in the third case, it would proceed till its velocity was reduced to an assignable portion of the difference between 36,700 and its initial velocity, and would then return, regaining its velocity by the same degrees, and in the same places, as it lost it. These are necessary consequences of a gravitating force directed to the centre of the earth, and inversely proportional to the square of the distance. But, in the greatest projections that we are able to make, the gravitations are so nearly equal, and in directions so nearly parallel, that it would be ridiculous affectation to pay any regard to the deviations from equality and parallelism. A bullet rising a mile above the surface of the earth loses only $\frac{1}{2000}$ of its weight, and a horizontal range of four miles makes only four minutes of deviation from parallelism.

Let us therefore assume gravitation as equal and parallel. The errors arising from this assumption are quite insensible in all the uses which can be made of this theory.

The theory itself will ever be regarded with some veneration and affection by the learned. It formed the first fruits of mathematical philosophy. Galileo was the first who applied mathematical knowledge to the motions of free bodies, and this was the subject on which he exercised his fine genius.

Gravity must be considered by us as a constant or uniform accelerating or retarding force, according as it produces the descent, or retards the ascent, of a body. A constant or invariable accelerating force is one which produces a uniform acceleration; that is, which in equal times produces equal increments of velocity, and therefore produces increments of velocity proportional to the times in which they are produced. Forces are of themselves imperceptible, and are seen only in their effects, and they have no measure but the effect, or what *measures* the effect; and every thing which we can discover with regard to those measures, we must affirm with regard to the things of which we assume them as the mea-

sures. Therefore, the motion of a falling body, or of a body projected directly downwards, is uniformly accelerated, and that of a body projected directly upwards is uniformly retarded: that is, the acquired velocities are as the times in which they are acquired by falling, and the extinguished velocities are as the times in which they are extinguished.

Cor. 1. If bodies simply fall, not being projected downwards by any external force, the times of the falls are proportional to the final velocities; and the times of ascents, which terminate by the action of gravity alone, are proportional to the initial velocities.

2. The spaces described by a heavy body falling from rest, are as the squares of the acquired velocities; and the differences of these spaces are as the differences of the squares of the acquired velocities; and, on the other hand, the heights to which bodies projected upwards will rise, before their motions will be extinguished, are as the squares of the initial velocities.

3. The spaces described by falling bodies are proportional to the squares of the times from the beginning of the fall; and the spaces described by bodies projected directly upwards, are as the squares of the times of the ascents.

4. The space described by a body falling from rest is one half of the space which the body would have uniformly described in the same time with the velocity acquired by the fall; and the height to which a body will rise, in opposition to the action of gravity, is one half of the space which it would uniformly describe in the same time with the initial velocity.

In like manner the difference of the spaces which a falling or rising body describes in any equal successive parts of its fall or rise is one half of the space which it would uniformly describe in the same time with the difference of the initial and final velocities.

This proposition will be more conveniently expressed for our purpose thus:

A body moving uniformly during the time of any fall with the velocity acquired thereby will in that time describe a space double of that fall; and a body projected directly upwards will rise to a height which is one half of the space which it would, uniformly continued, describe in the time of its ascent with the initial velocity of projection.

5. It is a matter of observation and experience, that a heavy body falls rather more than sixteen feet in a second of time, and therefore acquires the velocity of thirty-two feet per second. This cannot be ascertained directly with the precision that is necessary. A second is too small a portion of time to be exactly measured without some mechanical contrivance; but it is done with the greatest accuracy by comparing the motion of a falling body with that of a pendulum. The time of a vibration is to the time of falling through half the length of the pendulum as the circumference of a circle is to its diameter. The length of a pendulum can be ascertained with great precision, and it can be lengthened or shortened till it makes a given number of vibrations in a day.

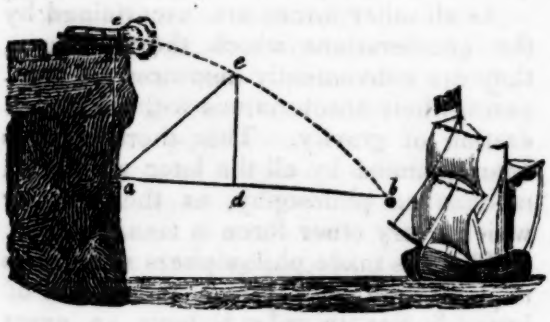
Atwood's machine, which has already been described under that article, furnishes us with a very beautiful mode of illustrating the velocity which a falling body acquires in a given time. And here we may digress for an instant to point out the advantages which our modern schools of science and public lecture rooms possess over those in the "olden time." Newton is said to have had his attention directed to the subject of gravitation by the fall of an apple, and if he had desired to illustrate the subject familiarly, he must still have pursued the same course with his pupils. Instead, however, of an apple or stone descending from the roof of the lecture room, with the velocity of the wind, we now see a large brass weight, that the eye can easily follow, passing over a graduated scale, and exactly measuring the velocity it has acquired in every part of its path.

As all other forces are ascertained by the accelerations which they produce, they are conveniently measured by comparing their accelerations with the acceleration of gravity. This, therefore, has been assumed by all the later writers on mechanical philosophy, as the unit by which every other force is measured.

This has made philosophers so anxious to determine with precision the fall of heavy bodies, in order to have an exact value of the accelerating power of terrestrial gravity. Now, we must here ob-

serve, that this measure may be taken in two ways: we may take the space through which the heavy body falls in a second; or, we may take the velocity which it acquires in consequence of gravity having acted on it during a second. The last is the proper measure. The action of gravity has changed the state of the body—and this is effected by giving it a determination to motion downward; this both points out the kind and the degree or intensity of the force of gravity. The space described in a second by falling is not an invariable measure; for in the successive seconds, the body falls through 16, 48, 80, 112, &c. feet, but the changes of the body's state in each second is the same. At the beginning it had no determination to move with any appreciable velocity; at the end of the first second it had a determination by which it would have gone on for ever (had no subsequent force acted on it) at the rate of thirty-two feet per second. At the end of the second second it had a determination by which it would have moved for ever at the rate of sixty-four feet per second. At the end of the third second it had a determination by which it would have moved for ever at the rate of ninety-six feet per second, &c. &c. Thus, the difference is a determination to the rate of thirty-two feet per second. This is therefore constant, and the indication and proper measure of the constant or invariable force of gravity.

It would be foreign to our present purpose to enter into any very elaborate illustration of the path of a projectile as applied to the science of gunnery, and it may be enough to furnish our readers with a familiar view of the general effects of gravitation as applied to the subject.



In the above diagram *a d b* represent the horizontal path of a ball supposed to be projected from the point *a*. Now, in this case we suppose the existence of no gravitating force; but, as there is a continual tendency in all bodies to approach towards the earth's surface, we must place the cannon at *e* if we wish the ball to arrive at *b*. This is a necessary result of the law which draws all bodies towards the earth's centre. Instead of placing the piece at the elevation shown in the diagram, the gunner elevates the point of his piece, and by giving it an ascending range ensures his object with equal certainty. Thus he would direct his piece from *a* in the direction of *c*, and although it would not take precisely the path *a c*, yet it would go for a certain distance nearly in a straight line, and then change its path till it arrived at *b*, a little beyond which it would strike the ship. The British sailors, from long experience and much practice, rather than from a high degree of science, have obtained considerable precision in the range of their guns.

In the practice of cannonading it is necessary to come as near as possible to the object aimed at, as the hurry of service allows no time for geometrical methods of pointing the piece after each discharge. The gunner either points the cannon directly to the object, when within 200 or 300 yards of it, in which case he is said to shoot point blank; or, if at a greater distance, he estimates to the best of his judgment the deflection corresponding to his distance, and points the cannon accordingly. Or lastly, when the intention is not to batter, but to rake along a line occupied by the enemy, the cannon is elevated at a considerable angle, and the shot discharged with a small force, so that it drops into the enemy's post, and bounds along the line. In all these services the gunner is directed by his practice.

The principal use of the parabolic theory is to direct the bombardier in throwing shells. With these it is proposed to break down or set fire to buildings, to break through the vaulted roofs of magazines, or to intimidate and kill troops by bursting among them. These objects are always under cover of the enemy's works, and cannot be touched by a direct shot. The bombs are therefore thrown upwards, so as to pass over the defences and produce their effect.

These shells are frequently many hundred pounds in weight. The mortars from which they are discharged must, therefore, be very strong, that they may resist the explosion of gunpowder which is necessary for throwing such a mass of matter to a distance. Very little change can be made in their elevation, and therefore their ranges are regulated by the velocities given to the shell. These again are produced by the quantities of powder in the charge; and experience (confirming the best theoretical opinions that we can form of the subject) has taught us that the ranges are nearly proportional to the quantities of powder employed, only not increasng quite so fast. This method is much easier than by differences of elevation; for we can select the elevation which gives the greatest range on the given plane, and then we are certain that we are employing the smallest quantity of powder with which the service can be performed: and we have another advantage, that the deviations which unavoidable causes produce in the real directions of the bomb will then produce the smallest possible deviation from the intended range.

The only other circumstance in which we are interested is the time of the flight. A knowledge of this is necessary for the bombardier, that he may cut the fusees of his shells to such length as that they may burst at the very instant of their hitting the mark.

In making experimental observations on the path of a projectile, a jet of water or mercury gives us the finest example, because we have the whole parabola exhibited to view in the simultaneous places of the succeeding particles. Yet even in these experiments a deviation can be observed. When the jet is made on a horizontal plane, and the curve carefully traced on a perpendicular plane held close by it, it is found that the distance between the highest point of the curve and the mark is less than the distance between it and the spout, and that the descending branch of the curve takes a more perpendicular direction than the ascending branch. And this difference is more remarkable as the jet is made with greater velocity, and reaches to a greater distance. This is evidently produced by the resistance of the air, which diminishes the velocity, without affecting the gravity of the projectile. It is still more sensible in the motion of bombs. These can be traced through the air by the light of their fusee; and we see that their highest point is always much nearer to the mark than to the mortar on a horizontal plane.

The greatest horizontal range on this plane should be when the elevation is 45 degrees. It is always found to be much lower.

The ranges on this plane should be as the sines of twice the elevation. A ball discharged at the elevation of 19°·5′, ranged 448 yards; at the elevation of 9°·45′, 330 yards. It should have ranged by theory 241 yards.

The range at an elevation of 45° should be twice the impetus. And it has been found by experiment that a musket ball, discharged with the usual allotment of powder, has the velocity of 1700 feet in a second. This requires a fall of 45,·156 feet, and the range should be 90,·312, or 17$\frac{1}{8}$ miles; whereas it does not much exceed half a mile. A twenty-four pound ball, discharged with sixteen pounds of powder, should range about 16 miles; whereas it is generally short of three miles. As the motion of projectiles is performed in the atmosphere, it follows that the air is displaced or put in motion. Whatever motion it acquires must be taken from the bullet. The motion communicated to the air must be in the proportion of the quantity of air put in motion, and of the velocity communicated to it. If, therefore, the displaced air be always *similarly displaced*, whatever be the velocity of the bullet, the motion communicated to it, and lost by the bullet, must be proportional to the square of the velocity of the bullet and to the density of the air jointly. Therefore, the diminution of its motion must be greater when the motion itself is greater, and in the very great velocity of shot and shells it must be prodigious. It appears from repeated experiments, that a globe of four inches and a half in diameter, moving with the velocity of twenty-five feet in a second, sustained a resistance of 315 grains, nearly three-quarters of an ounce. Suppose this ball to move 800 feet in a second, that is, thirty-two times faster, its resistance would be 32 × 32 times three-

quarters of an ounce, or 768 oz., or 48 lbs. This is four times the weight of a ball of cast iron of this diameter; and if the initial velocity had been 1600 feet per second, the resistance would have been at least sixteen times the weight of the ball. It is indeed much greater than this.

This resistance, operating constantly and uniformly on the ball, must take away four times as much from its velocity as its gravity would do in the same time. We know that in one second gravity would reduce the velocity 800 to 768, if the ball were projected straight upwards. This resistance of the air would therefore reduce it in one second to 672, if it operated uniformly; but as the velocity diminishes continually by the resistance, and the resistance diminishes along with the velocity, the real diminution will be somewhat less than 128 feet. We shall, however, see afterwards, that in one second its velocity will be reduced from 800 to 687. From this simple instance, we see that the resistance of the air must occasion great deviation from parabolic motion. In order to judge accurately of its effect, we must consider it as a retarding force, in the same way as we consider gravity.

If we consider this resistance as a retarding force, we can compare it with any other such force by means of the retardation which it produces in similar circumstances. We may compare it with gravity by comparing the diminution of velocity which its uniform action produces in a given time with the diminution produced in the same time by gravity. But we have no opportunity of doing this directly; for when the resistance of the air diminishes the velocity of a body, it diminishes it gradually, which occasions a gradual diminution of its own intensity. This is not the case with gravity, which has the same action on a body in motion or at rest, so that we cannot observe the uniform action of the air's resistance as a retarding force. We must therefore substitute some other way of making the comparison. We can state them both as dead pressures. A ball may be fitted to the rod of a spring steelyard, and exposed to the impulse of the wind. This will compress the steelyard to the mark 3, for instance. Perhaps the weight of the ball will compress it to the mark 6. We know that half this weight would compress it to 3. We account this equal to the pressure of the air, because they balance the same elasticity of the spring. And in this way we can estimate the resistance by weights whose pressures are equal to its pressure, and we can thus compare it with other resistances, weights, or any other pressures. In fact, we are measuring them all by the elasticity of the spring. This elasticity in its different positions is supposed to have the proportions of the weights which keep it in these positions. Thus we reason from the nature of gravity, no longer considered as a dead pressure, but as a retarding force; and we apply our conclusions to resistances which exhibit the same pressures, but which we cannot make to act uniformly.

The most elaborate mathematical calculations lead us to the following important results.

1. Balls of equal density, projected with the same elevation, and with velocities which are as the square roots of their diameters, will describe similar curves. This is evident, because in this case the resistance will be in the ratio of their quantities of motion. Therefore, all the homologous lines of the motion will be in the proportion of the diameters.

2. If the initial velocities of balls projected with the same elevation are in the inverse sub-duplicate ratio of the whole resistances, the ranges, and all the homologous lines of their track, will be inversely as those resistances.

These theorems are of considerable use, for by means of a proper series of experiments on one ball projected with different elevations and velocities, tables may be constructed which will ascertain the motion of an infinity of others.

We shall conclude this article by giving two or three tables, computed from the principles established above, and which serve to bring into one point of view the principal circumstances of the motion in a resisting medium. In a series of experiments made at Woolwich, which were continued for several days, not only do the experiments of one day differ among themselves, but the mean of all the experiments of one day differs from the mean of all the experiments of another no less than one fourth of the

whole. The experiments in which the greatest regularity may be expected, are those made with great elevations. When the elevation is small, the range is more affected by a change of velocity, and still more by any deviation from the supposed or intended direction of the shot.

I.	II.	III.
2	92	420
4	121	428
9	159	456
18	200	470
32	272	479

The first table shows the distance in yards to which a ball projected with the velocity of 1600 will go, while its velocity is reduced one tenth, and the distance at which it drops sixteen feet from the line of its direction. This table is calculated by the resistance observed in Mr. Robins' experiments. The first column is the weight of the ball in pounds. The second column remains the same whatever be the initial velocity, but the third column depends on the velocity. It is here given for the velocity which is very usual in military service, and its use is to assist us in directing the gun to the mark. If the mark at which a ball of twenty-four pounds is directed is 474 yards distant, the axis of the piece must be pointed sixteen feet higher than the mark. These deflections from the line of direction are nearly as the squares of the distances.

I.	II.	III.	IV.	V.
200	416	349	106	360
400	1664	1121	338	1150
600	3740	1812	606	1859
800	6649	2373	866	2435
1000	10390	2845	1138	2919
1200	14961	3259	1378	3343
1400	20364	3640	1606	3734
1600	26597	3950	1814	4050
1800	33663	4235	1992	4345
2000	41559	4494	2168	4610
2200	50286	4720	2348	4842
2400	59846	4917	2460	5044
2600		5106	2630	5238
2800		5293	2762	5430
3000		5455	2862	5596
3200				5732

The next table contains the ranges in yards of a twenty-four pound shot, projected at an elevation of 45°, with the different velocities in feet per second expressed in the first column. The second column contains the distances to which the ball would go in vacuo in a horizontal plane; and the third contains the distances to which it will go through the air. The fourth column is added to show the height at which it rises in the air; and the fifth shows the ranges corrected for the diminution of the air's density as the bullet ascends, and may therefore be called the *corrected range*.—[Partington.]

[From the "American Journal of Science and the Arts," for January, 1835.]

Large Mass of Native Copper.—The cabinet of Yale College has been recently enriched by a magnificent piece of native copper, presented by Mr. J. Mortimer Catlin, of New-York. In a letter to the editor, dated October 9, 1834, Mr. C. mentions that this piece of copper was found at or near the river On-ta-naw-gaw of Lake Superior; and, as we are informed, above the rapids marked on the map of the river. Those who brought it away were allured by the vain hope of finding in it gold or silver. Its weight was one hundred and thirty-seven pounds, but is now somewhat less, as a few ounces have been detached. It has all the characters of native copper; the perfect color and lustre of that metal; the occasional incrustation of green carbonate of copper; numerous rudiments of crystals of copper, with triangular faces; occasional cavities, swellings, and knobs, and great malleability. Its form is rudely plano-convex, with an irregularly elliptic base, arched below, and standing upon two projections, thus allowing it a rocking motion; it is fifteen inches long and fifteen broad—in the narrowest place twelve inches; it is nine inches high, and it bears strong marks of having been entangled in a vein stone, or a rock. Mr. Catlin has been credibly informed, that "there lies in the bed of On-ta-naw-gaw a mass equally pure, weighing a ton!"

Whether this is the celebrated copper rock described by Mr. Schoolcraft, vol. iii., p. 205, of this Journal, we have no means to determine, but the numerous and important facts mentioned by Mr. School-

craft render it certain that native copper is frequently found in that region, and lead to a strong presumption of the existence of valuable mines of copper.

—

Great Mass of Meteoric Iron from Louisiana.—The history of this iron was given in vol. viii., at p. 218, of this Journal. The first notice of it was published in Dr. Bruce's Journal in 1810, and it was there stated that it contained no nickel; a subsequent examination by Professor Silliman detected that metal; and a more exact analysis by Mr. Charles U. Shepard ascertained the existence of 9.67 per cent. of nickel in this very remarkable mass. See this Journal, vol. xvi., p. 217. It was, for many years, deposited in trust, in the Museum of the Lyceum of New-York, by the late Col. Gibbs, who had early purchased the specimen. That gentleman's lamented death was mentioned in this Journal, vol. xxv., p. 214. Recently, his respected lady, Mrs. Laura Gibbs, with the approbation of those concerned, has generously presented this magnificent mass to the Cabinet of Mineralogy of Yale College, thus causing it to be associated with the splendid collection, the Gibbs Cabinet, which was amassed by the labor and munificence of him whose name it bears, and to whose memory we trust it will long continue to honor. In this collection, unrivalled in the United States, and surpassed in few other countries, the Meteoric Iron of Louisiana is, without doubt, the most important specimen.

A more particular notice of it may be given on another occasion. Its length is three feet four and a half inches, its greatest breadth two feet four inches, and its greatest height sixteen inches. Its weight is sixteen hundred and thirty-five* pounds, being more than that of the mass found by Professor Pallas in Siberia, which is now in the Imperial Museum at St. Petersburgh.

The Gibbs Meteoric Iron is, therefore, the largest piece in any collection in the world, although there are masses many times larger lying in the wild regions of Mexico and Peru, and perhaps elsewhere.

* The weight was reported, in Dr. Bruce's Journal, to be over three thousand pounds, which exaggerated statement has been often repeated, and was probably derived from the adventurers who brought it from the Red River.

—

Soapstone or Steatite, of Middlefield.—This very useful material is found in many places in our primary regions. Middlefield, in Massachusetts, eighteen miles from Northampton, has long been known as affording it in abundance. A new quarry has been recently opened there, by Mr. William H. Butler, from whom we have received slabs and fragments. The quality is excellent, the substance is principally compact talc, and it is, (as far as we can judge from the specimens sent us,) remarkably free from foreign minerals. It gives a surface of uniform level and finish, and is cut with great ease. When varnished, fine colors are brought out, not unlike those of the Verd antique marble of Milford, near New-Haven, but less vivid. It is, however, sufficiently handsome to be used for the facings of fireplaces.

We should be glad to receive information of all remarkable masses of soapstone in this country, that we may contribute to make them still further known. The utility of soapstone is immense, and is only beginning to be realized among us. It is an admirable building material—cut with almost as much ease as timber, and readily shaped to any form for utility or ornament; it is as handsome as granite and marble, and houses constructed of it would not be injured by fire, as it resists that powerful agent, even in furnaces,* for which it forms an excellent lining.

Anthracite furnaces, when lined with it, instead of fire bricks, do not accumulate the slag and scoriæ, and the walls remain perfectly clean; this arises from the infusibility of the soapstone, which prevents the slag from adhering to it; the slag consists of the earthy and metallic impurities of the coal, which melt in the intense heat of the anthracite furnaces, and then adhesion takes place in consequence of the softening of the fire bricks at their furnaces, where they are in contact with the slag. Soapstone, on account of its infusibility, is also an excellent ingredient in pottery and porce-

* It is said, however, not to stand in the furnace for smelting iron.

lain; and magnesia, which is its characteristic ingredient, may be extracted from it by very easy chemical processes.

—

WATER OBTAINED BY BORING. (J.G.)—*Artesian Wells* have been very successfully constructed in some parts of France. A letter from *M. Jauburt de Passa* to Viscount *Hericart de Thury*, describes a bored well, remarkable for the abundance of water which it supplies. It was made by *M. Durand*, two leagues southeast of Perpignan.

The sound, after penetrating to the depth of eighty feet, through alternate beds of marl and clay, entered a bed of sandy marl, three feet thick, where issued a jet of water, very clear, but from the peculiarity of its taste, unfit for drinking. Its temperature was 14°.5 Reaumur, (= 65° Fahrenheit,) and it rose from three to four feet above the surface.

A second boring, undertaken at the distance of six feet from the first, gave, at the same depth, a jet of water, but the first jet diminished, and the quantity of water from both was less than that which first issued from the former. The boring of the latter was then continued to the depth of one hundred and forty-five feet, when the sound began to sink of itself, and when precipitately withdrawn, the water rushed up, to the height of five feet, and astonished all by its abundance and force. No obstacle could restrain it. No direct attempt was made to determine the maximum height to which it might rise, but fifty feet was decreed to be fully within the limits of its ascending force.

At the time the letter was written, several weeks after the first issue of the water, it continued to flow with the same violence, and with rather increased quantity. From the dimensions and velocity of the current, it appeared to supply four hundred and thirty gallons per minute, or two thousand eight hundred and eighty cubic metres per day. A leaden weight of eight pounds, supported by a string, being placed in the tube, was rapidly thrown out by the water.

The water, which at first had a peculiar taste, but not disagreeable, is now very limpid and insipid, and its temperature 66° of Fahrenheit. The total expense of the well was two hundred and sixty-three francs.—[Bull. D'Encouragement, Sept., 1833.]

[From the Journal of the Franklin Institute.]

Remarks and Calculations on the best form for Railway Bars, and on the defects which exist in the present method of supporting the same. By R. STEPHENSON, Engineer.

It is abundantly proved, both by experiment and mathematical demonstration, that when a beam is supported at both ends, and sustains a load, either uniformly distributed over the whole length, or placed at any point between the supports, it is of equal strength throughout, if the form be a semi-ellipsis. In practice, this form is almost invariably adopted as the most economical, giving the greatest strength with the least quantity of material, especially in cast iron, which admits of the elliptical shape being accurately given to the beam. So long, therefore, as cast iron was employed for railway purposes, the elliptical rail was adopted by common consent. The circumstance, also, of this kind of rail, when carefully proportioned, scarcely ever breaking in precisely the same part of the length, proved experimentally that the form given to them was a close approximation to that of equal strength.

On the substitution of malleable for cast iron for railway bars, it was considered impracticable to give the elliptical shape to the rails; the first malleable iron rails were, consequently, made parallel, or uniform in depth, throughout the whole length between each bearing. This deviation from the elliptical form was deemed, by some engineers, a serious defect; so much so, that the extension of the use of the malleable iron for railway bars was for some time retarded: this difficulty, however, was surmounted by an ingenious application of an eccentric roller, by which a form was produced, which, though it did not correspond accurately with the equation of the ellipse, yet approached it so nearly as scarcely to admit of any deviation being made with advantage.

Since the introduction of this form for malleable iron rails, some engineers have returned to the original parallel rail, conceiving that the application of the eccentric roller tends to destroy the uniform arrangement amongst the fibres of the iron, which in the parallel rail may be reasonably considered to extend uninterruptedly from end to end of the rail, which is, consequently, better prepared to withstand the kind of strain to which it is to be subjected.

How far this anticipation is correct, is evidently more a matter of experiment than of calculation; it may, however, be interesting, in the first place, to compare the relative theoretical strengths of the elliptical and parallel rails, on the supposition that they are of the same weight for a given distance; and afterwards to compare the theoretical deduction with experiment, which will show the dependence to be placed on the application of the formula to cases where experiment is not within reach.

It is well ascertained that the transverse strength of beams varies directly as the breadth and square of the depth, and inversely as the length. It may be represented thus, $\frac{b \cdot d^2}{l}$; when b = breadth, d = depth in the middle of the length, and l = length. In comparing the parallel and elliptical rails, the breadth and length may be taken as constant; the relative strength will therefore vary as d^2. Now, if d = depth of the elliptical rail in the middle, and x = the difference of depth between the middle and the ends, (or what is usually denominated "the belly of the rail,") $d - \frac{1}{2}x$ will be, nearly, the depth of a parallel rail of equal weight; the relative strengths of the two rails will therefore be as $d^2 : (d - \frac{1}{2}x)^2$, or, $1 : \frac{(d - \frac{1}{2}x)^2}{d^2}$.

The last fraction is clearly less than 1; consequently, the strength of the parallel rail must always be less than the elliptical, and will depend on the magnitude of x, or the swell of the rail.

In the view just taken, it will be observed that the projecting ledge on each side of the vertical rib, forming the surface of the rail, has made no part of the consideration, because it is common to each kind of rail. It is not difficult to introduce it, but it would add to the intricacy of the formula, and would give a result a little more in favor of the elliptical rail, as it would elevate the neutral axis, and thus operate in favor of that rail which has the greatest depth.

The above formula applies merely to a vertical pressure; but as railway bars are also subject to severe lateral strains, it may be well to point out, in this respect, where the elliptical rail still has the advantage.

A lateral strain upon a railway bar is evidently nothing more than a vertical pressure, if the rail be supposed laid upon its side; the same formula then applies, making b and d change places, for what was the breadth in the former case now becomes the depth, and as the depth and length are supposed the same, the relative strengths will be directly as the breadths; that is, as $b : (b - \frac{1}{2}x.)$

These results are, however, only applicable to the calculation of the ultimate strength; but in considering the relative advantages of railway bars, the ultimate strength of which ought, in all cases, far to exceed the working strain, it would appear that the quantity of deflexion, rather than the breaking load, ought to be the measure of their comparative merits.

It will be readily admitted, on a little consideration, that great, if not absolute, rigidity is extremely desirable in a railway bar; and, though it may be impossible to attain this object, we are justified in making every effort to approach it, by adopting that form of rail which possesses the greatest stiffness, with the least quantity of material. It is in this respect that the increased depth of the rail, obtained by making the longitudinal section a semi-ellipsis, produces a very sensible advantage, and places the merits of the latter form in a much stronger light, than the comparison of the ultimate strengths.

The stiffness, or rigidity, of beams has been proved by Barlow, Young, Tredgold, and others, by a great variety of experiments, to vary directly as the breadth and cube of the depth, and inversely as the cube of the length. When, therefore, the lengths and breadths of the two beams are the same, the relative stiffness will be as the cube of the depth only. Now, the depths at the middle of an elliptical and parallel rail of the same weight, have already been stated to be as $d : d - \frac{1}{2}x$. The relative stiffness will therefore be as $d^3 : (d - \frac{1}{2}x)^3$, or as $1 : \frac{(d - \frac{1}{2}x)^3}{d^3}$, a proportion much more in favor of the elliptical rail, than that previously stated as representing the ultimate strength.

This ratio, it must be observed, requires modification, owing to the circumstance of a parallel beam being more rigid than an elliptical beam of the same depth in the centre; this deduction, however, is not such as to interfere in a great degree with the result indicated by the formula, as will be shown by the experiments adduced in the sequel of these remarks.

In determining the form of railway bars, little, if any, attention has been paid to the question of deflexion; it appears, therefore, the more necessary in this instance to consider its effects, as it is apprehended that it is productive of several injurious consequences, which have hitherto been attributed to a wrong cause. The usual method of uniting the rail chairs and blocks, by keys and pins, tends clearly to form the whole into an inflexible line, no one part being capable of changing its position,

without producing a corresponding change, or distortion, in the adjoining one. Immediately, therefore, on the slightest deflexion taking place in the rail between the supports, the position of the key which connects the rail and chair is disturbed, as it necessarily has a tendency to assume the same angular position as the rail. If this tendency is resisted by the grooved recess in the chair, for the reception of the key, the effect is merely to transfer the tendency from the key to the chair, which is thereby made to rest on one side, or arris, of its base, and on the other alternately. This continual transfer of strains from the rail to the key, from the key to the chair, and, finally, from the chair to the block, or sleeper—originating from the deflexion of the rail—never fails to destroy one or both of these connections; thus giving rise, not merely to perpetual expense in replacing keys, but to a continual jarring noise when carriages pass over them, from the looseness of the rail and key in the chair. Now, it being absolutely impossible to make the rail between each two supports perfectly inflexible, it seems only reasonable to conclude that every attempt to connect the parts, so that one portion of the structure partakes, in a greater or less degree, of the movements of the adjoining one, must be abortive. This is on the supposition that the inevitable deflexion in the rail is the only source of derangement; but when we add to this, the constant settling of the foundation upon which the blocks are placed, as well as the unequal yielding of the same, which destroys the parallelism between the surface of the rail and the bed of the block, the consequences just alluded to present themselves with increased force.

These reflections appear to countenance the conclusion that much advantage would be derived from the adoption of some method of connecting the rail and chair, which would admit of deflexion in the rail, as well as a change in the position of the block, without destroying the accuracy and efficiency of the connections.

A model of rail and chairs, contrived with the view of obviating the imperfections arising out of what may be termed the "inflexible" plan of connecting the rail and chair, accompanies these remarks. The method described by the model is not affirmed to be free from objection, but is suggested as much less objectionable than the method usually followed, and may be regarded as a step towards that perfection which, it is hoped, will, ere long, be attained in this very important part of the construction of a railway.

If the view here taken be correct, that is, if the deflexion of the rail is one of the principal causes of the present rapid working loose of the rails, keys, and chairs—which would continue to be the case, even after the road has obtained a firm and solid foundation—it is evident that, in order that the quantity of deflexion may be diminished, a stronger rail than has been hitherto employed, is desirable, independent of any consideration in reference to increased weights to be conveyed.

The next, and perhaps the most apparent cause of derangement in the accuracy of a railway, is the yielding of the material which supports the road; and as the practical operation of this shrinkage points to a comparison between the parallel and elliptical rail, it may be well to direct attention to it in an especial manner.

When a malleable iron railway bar is first laid and adjusted, each support throughout the five yards, (the ordinary length of each rail,) may be considered as duly performing its part. Immediately on any of the intermediate supports yielding, or falling below the general level, from the unsoundness, or from the consolidation of the ballasting, the block is forced, by the superincumbent weight, deeper into the ground; as soon as the weight has passed over, the elasticity of the iron (which is not destroyed) causes the surface of the rail to resume its original level; it cannot, however, do this, without lifting the block from the bed, or foundation, into which it was forced, during the progress of the weights along the rail. This effect is not perceptible, until the operation has been frequently repeated; but it is easy to perceive, that as long as the elasticity of the rail remains perfect, and the solidity of the foundations of the road imperfect, the operation of alternately forcing the block deeper into the ground, and suspending it by the elasticity of the rail, must, as a necessary consequence, be going on in every railway where long malleable iron rails are employed, with several supports under each rail. It is obvious that each block so lifted, (on weights being passed over the rail,) must be forced as by a violent blow upon the foundation, thus rapidly accelerating the sinking of the ballasting, and the destruction of the parts, when once allowed to become defective. Now, the tendency to the operation just described, can only be counteracted by increasing the weight of the blocks, and diminishing the elasticity of the rail at the point of bearing; it is, however, impracticable to adopt either of these expedients to an extent that would, in a material degree, approach to the removal of the effect, because any feasible increased weight of block is inappreciable, when compared with the elasticity of the rail. The effect is mentioned in this place, merely to prove that the reduction in strength at the point of support ought not to be looked

upon as a defect in the elliptical rail; indeed, it may be made to appear that such a reduction is desirable, rather than the contrary: it will, therefore, be necessary to show that these observations respecting the suspension of the blocks, and the rapid succession of violent blows, like that of a ram, upon the ballast, are not merely ideal.

This is forcibly illustrated by a comparison of the expense of keeping malleable and cast iron railways in order, the latter scarcely exceeding one half the former, and in some cases (if report is to be received) rather less than that proportion.

It may, perhaps, be objected, that a comparison between cast and malleable iron, on different railways, is not a suitable criterion, as the traffic and speed may be so far different as to account for the difference of expense; this objection is, fortunately, not tenable, as applied to the Darlington Railway, because there the cast iron rails are placed on an embankment, over which the traffic and speed are the same as on other parts of the line. Here the comparison is decidedly in favor of the cast iron, and, as I have been informed, in about the proportion above stated; and, although I have not been able to obtain an exact detail of the expenses of each, the chairman of that railway company informed me, that after careful and minute examination, he had completely satisfied himself on the point, and as it corroborates my own observations, I am led to regard it as a well established fact. The only difference in construction between the two descriptions of rails, consists in the cast iron rail having a flexible joint above each support; when, therefore, the foundation sinks, the blocks sink with it; but, there being no re-action, from the elasticity of the rail, the blocks never become suspended; consequently, the ram-like action is never called into play. This leads to the conclusion, that flexibility above the supports is not so weighty an objection to the elliptical rail as has been imagined.

It has been sometimes urged as an advantage in favor of the parallel rail, that the great strength above the supports enables it to sustain the load, even though the block may have sunk below the original level. If this be true, it appears to amount to little more than an admission that it is unnecessarily strong when supported by the blocks, which it in fact always is, because the deflexion of any railway bar of the ordinary strength, where the supports are six feet apart, would be so great as to render rapid velocities more destructive than they are; for the deflexion being directly as the cube of the length, would be eight times greater than where the rail is supported at every yard; moreover, the supports of a railway should never be allowed to assume that condition in which one-half of the blocks are supposed to become useless. Preparing, therefore, by the adoption of parallel rails, for circumstances which it is not only practicable to avoid in a public line of road, but ought never to be allowed to take place, appears at least unnecessary; but when it is recollected, in addition to this, that the material thus expended in adding strength to the rail, above the supports, may be applied to other parts of the rail, where strength is more required, it certainly increases the inducement to follow the elliptical form.

The difficulty of manufacturing, and a proportionate increase of expense in, the elliptical rail, have, it is believed, been the principal causes of its rejection by some. To these I have endeavored to give the most impartial consideration; and with respect to the difficulty of manufacturing, if any really exist, I am convinced it arises from inexperience, as the operation consists, in addition to the rolling of ordinary bar iron, of merely once or twice passing it through the rollers by which the elliptical shape is given. That this should be considered a difficulty, creating an objectionable expense, is somewhat remarkable, since it occupies but a few seconds.

It is not improbable that the true source of this objection, (which arose originally, I believe, with some iron-masters,) is to be found in the fact that it is difficult, if not impracticable, to introduce into the elliptical shaped rail, iron of inferior quality, as the nature of the process almost invariably detects it. This is a recommendation so palpable, that an endeavor has been made to countervail it by stating that the process by means of the eccentric roller destroyed the continuity of the fibres, and injured the strength of the rail. Experiment, of course, is our best guide, and on referring to this test, it does not countenance the supposition that iron, of the best quality, is sensibly injured by the process of rolling into the elliptical form. An examination of the table, hereafter referred to, will be a sufficient reply to this objection.

On a comparison of the chairs required for these two descriptions of rail, it will be found that they differ considerably in the depth of the recess for receiving the rail, that for the parallel rail being deeper, and the whole body of the chair higher, thus elevating the centre of gravity of the rail above the bearing surface at the bottom of the chair. Now, the chair for the elliptical rail is lower by a quantity equal to the swell of the rail, which of course brings the centre of gravity of the rail nearer to the bottom of the chair. This difference in the construction of the chair renders lateral blows less effective in straining it, and contributes

much to the steadiness of the rail in the vertical position, supposing each fitted with equal care and accuracy.

When the period arrived for laying down the rails on the Newcastle and Carlisle Railway, a difference of opinion existed amongst the engineers consulted by the Board of Directors. This occasioned them to resort to actual experiment upon rails, expressly made by the advocates of each class. They weighed 50 lbs. per lineal yard, and were designed of the form and dimensions deemed most suitable for such a trial, by each party. The following table describes each experiment, with every detail. The care taken throughout the experiments is evinced by the minutiæ of the measurements, the deflexion being ascertained to be less than the $\frac{1}{1000}$th part of an inch at every increase of load.

Experiments on the Comparative Strength of Different Malleable Iron Rails, Oct. 10, 1832.

Weights applied midway between bearings, in cwts.	Fish-bellied rail, length 15 ft. 9 3-4 inches, weight 262 lbs., equal to 49.3 lbs. per yard.						Parallel rail, length 10½ inches, weight 262 lbs., equal to 48.47 lb. per yard.						Fishbell'd rail, 40.6 lb. p. yd.	
	Bearings in 3 ft. 0 15-16 in. apart.		Bearings, 6 ft. 0 5-8 inch apart.		Bearings, 3 ft. 9 3-16 inches apart.		Bearings, 3 ft. 0 15-16 inch apart.		Bearings, 6 ft. 0 5-8 inch apart.		Bearings, 3 ft. 9 3-16 inch apart.		Bearings, 3 ft. 0 1-4 in. apart.	
	Deflexion, 20 in. from one bearing, and 16 15-16 in. from the other.	Deflexion, 11 in. from one bearing, and 25 5-16 in. from the other.	Deflexion, 34 1-8 in. from one bearing, and 38 4-8 in. from the other.	Deflexion, 29 1-2 in. from one bearing, and 43 1-8 in. from the other.	Deflexion, 21 1-16 in. from one bearing, and 24 1-8 in. from the other.	Deflexion, 15 1-8 in. from one bearing, and 30 1-16 in. from the other.	Deflexion, 20 in. from one bearing, and 16 15-16 in. from the other.	Deflexion, 11 in. from one bearing, and 25 15-16 in. from the other.	Deflexion 34 1-8 in. from one bearing, and 38 4-8 in. from the other.	Deflexion, 29 1-2 in. from one bearing, and 43 1-8 in. from the other.	Deflexion, 21 1-16 in. from one bearing, and 24 1-8 in. from the other.	Deflexion, 15 1-8 in. from one bearing, and 30 1-6 in. from the other.	Deflexion, 20 in. from one bearing, and 161-4 inches from the other.	Deflexion, 11 in. from one bearing, and 25 1-4 inches from the other.
20	2	2	17	17	5	4	3	3	14	14	8	6	4	3
34	4	4	43	38	9	8	8	6	40	37	16	14	8	7
48	6	5	63	60	15	14	13	10	69	67	24	21	14	11
62	9	8	89	81	21	19	18	12	84	79	32	28	20	17
76	12	11	112	94	29	25	23	16	110	104	41	32	26	23
90	16	14	121	110	35	31	28	20	138	131	48	39	31	28
104	19	16	156	144	42	36	34	23	161	153	55	45	37	31
118	22	19			48	41	38	26			60	50	44	38
132	25	21	Perm.	Perm.	56	46	43	30	Perm.	Perm.	69	58	51	44
146	28	23	Defl'n,	Defl'n,	63	54	47	44	Defl'n,	Defl'n,	78	65	58	50
160	32	27	12.	12.	69	61	50	30	4.	3.	87	72	66	55
174	35	29			76	68	55	41			97	80	72	61
188	37	30												
202	41	33			Perm.	Perm.	Perm.	Perm.			Perm.	Perm.	Perm.	Perm.
216	44	35			Defl'n,	Defl'n,	Defl'n,	Defl'n,			Defl'n,	Defl'n,	Defl'n,	Defl'n,
230	48	36			3.	3.	3.	2.			9.	8.	6.	4.
	No permanent deflexion.													

[Deflexion measured in 1088th parts of an inch.]

On examining the table, it will be seen that the deflexions were measured at a short distance on each side of the centre, between the bearings. This arose from the circumstance of the weight being applied at the centre, which, of course, rendered it inconvenient to apply instruments at that point for measuring the quantity of deflexion.

Without noticing the results at each addition of weight, as detailed in the table, which is sufficiently explanatory in itself, it may answer our present purpose to take the results indicated when that weight, which will probably be the maximum in practice, was applied, say 62 cwt. With this weight, the bearings three feet apart, and each rail equal to very nearly 49 lbs., the deflexion of the elliptical rail is to the deflexion of the parallel rail as eighteen to thirty, nearly.

If the comparison of the other deflexions exhibited by the table be followed up, it will be found that they do not differ essentially from the above ratio.

If the weights producing permanent deflexion (or that point where the elasticity of the material is destroyed) be compared, it is scarcely less decisive; for we find that 174 cwt. produced a permanent deflexion of three in the parallel rail, whereas 230 cwt. did not reach this point with the elliptical rail.

Referring again to the table, there is only one other point to which I would beg particularly to direct attention, as it seems to corroborate what has previously been stated, respecting the impropriety of relying upon

any ordinary railway bar for supporting the load, when the bearings are six feet apart. I allude to the deflexion which takes place with the weight of 62 cwt. placed on the parallel rail, when the distances between the bearings are increased to six, instead of three feet. Here we find, at $34\frac{1}{8}$ inches from one bearing, and $38\frac{1}{8}$ inches from the other, the deflexion amounted to $\frac{84}{100}$ of an inch, which, in round numbers, may be taken at one-tenth of an inch at the middle point.

Now, it must be borne in mind that this result is with a weight perfectly stationary, and, consequently, unassisted, in any way, by percussion; whereas, a similar load, moving on a railway, oscillates upon the springs of the engines, or carriages, and would produce an effect greater than $\frac{1}{10}$th of an inch, but permanent deflexion would take place at considerably less than $\frac{2}{10}$ths of an inch. We thus have it demonstrated how essential it is to preserve the blocks at a uniform level with malleable iron rails, otherwise the texture of the iron must soon become permanently destroyed. It also proves how seldom we can take advantage of that which is said to be the chief advantage of the parallel rail, and that only when the railway is in improper order, in which case (as the experiments most distinctly prove) there will be great risk of permanent deflexion.

This brings me to notice an apparent advantage which the parallel rail has over the elliptical rail, but which has never, to my knowledge, been adduced, or much insisted upon. In the parallel rail, any weight, when above a block, or support, is divided more equally over three supports than in the elliptical rail, owing to the greater flexibility of the latter immediately over each block, or sleeper. This, it must be confessed, appears to be a striking advantage; but it must be compared with the fact, that in cast-iron rails, where the flexibility of the rail is reduced to nothing, and where each support in succession bears the superimposed load, without transferring any portion to the adjoining blocks, the expense of keeping the road in order is less than in malleable iron roads. Hence, it seems fair to conclude that the capability, in a rail, of transferring a portion of the strain to the adjoining blocks, is productive of injurious consequences, which are not adequately compensated for by this apparent advantage.

It is worthy of mention, that this view of difficulties, or imperfections, arising out of having a number of bearings under one rail, is supported by a case in the construction of machinery, so nearly parallel, that it may be considered absolutely so, and fully appreciated by every practical mechanic. I allude to the difficulty and risk of placing more than two bearings under one axle-tree. It is found so difficult to keep such a construction in order, that it is scarcely ever adopted, and where the axle is long, it is generally divided into parts, making each bearing, and its portion of axle, independent. Now, this is precisely what is done in cast-iron railways; each support and rail has a duty to perform, which it does, independent of any other.

I am afraid this digression from the point more immediately under discussion, may appear irrelevant, but it is one which I feel is necessary, fully and clearly to explain the views expressed in the foregoing remarks, respecting the flexibility of the rails above the supports, which I hold to be beneficial in more respects than one; for, whilst the strength of the rail is rendered greater in the middle of its length, the height of the chair, and the level of the rail, is reduced, which contributes to the steadiness of the construction.

Having learned that the elliptical rail on the Liverpool Railway had frequently broken, I wrote to Mr. John Dixon on the subject. The following is an extract from his letter:

"Our old rails, I am convinced, are too weak; not for the waggons, but for engines that bear six tons on one pair of wheels; and the weakest part is evidently the end next a joint, for although as deep at that point as at the places where the other chairs are fixed, it has not the support from the *next rail*, as if it were welded there, or were one continuous bar, especially when the joint chair gets loose on the block, key loose, and the block, or sleeper, itself settles. In fact, they generally bend, or break, within *six or eight inches of the end of the rail*. I believe the best rail for economising iron would be to make all the rail undulating as usual, but the two extremes parallel, the parallel part to be as deep as the belly of the undulations; but probably this could not easily be made, and would be then only a substitute for a little more iron."

This intelligence induced me to ascertain, by calculation, the weakest point in the Liverpool rail, and compare it with Mr. Dixon's statement. If the calculation accorded with the practice, it is clearly easy to provide against a similar imperfection.

In the accompanying drawing,* figs. 1 and 2 are sections of the old Liverpool rail, weighing 35 lbs. per yard; figs. 3 and 4 are similar views of a proposed elliptical rail, to weigh 50 lbs. per yard. The relative strength of these two rails, at eight

* The drawing here referred to did not accompany the manuscript from Mr. Stephenson.

inches from the end, is as 6 to 15.3, or rather more than 1 : $2\frac{1}{2}$.

Such an increase of strength beyond those employed on the Liverpool and Manchester Railways, which were used for temporary purposes, and thereby injured, during the execution of the work, would appear to be ample.

If we apply the formula which has already been given for the strength of the rails, to the Liverpool elliptical rail, we shall find that it indicates the weakest point at about nine inches from the end, being, in fact, at that point of the curve where it deviates most from the true ellipse, which would have been equally strong throughout.

Now, the depth of the elliptical rail, at nine inches from the end, is exactly the depth due to a parallel rail of the same weight per yard. We have, therefore, data to calculate what would have been the strength of the parallel rail in the middle of its length, compared with the strength of the elliptical rail at that point, which has been found insufficient for six tons upon a pair of wheels, as stated in Mr. Dixon's letter.

The depth of the Liverpool rail, at the point of fracture may be taken at $2\frac{7}{8}$ inches: whereas the depth of a parallel rail of equal weight would be three inches; the relative strengths of the two rails, at the usual place of fracture, would be $\overline{2\frac{7}{8}}|^2$, $\overline{3}|^2$, or as $8\frac{1}{4}$: 9, in favor of the parallel rail at this point.

Now, to continue the comparison, we must suppose the same load which broke the elliptical rail at seven inches from the end, transferred to the middle of the parallel rail, and calculate its adequacy under these conditions.

Since we find the elliptical rail break at seven or eight inches from the end, where the depth is $2\frac{3}{4}$ inches, we are perhaps near the truth in taking three inches as the proper depth, being the depth of the parallel rail, which we have just shown has the advantage over the other in the rate of $8\frac{1}{4}$: 9.

We know also that the strain produced by the same weight, placed in different parts of a beam, is as the rectangle of the segments into which the beam is divided; the comparative strains, therefore, produced by a given weight, seven inches and eighteen inches from the end, will be as $7 + 29 : 18^2$, or as 5 : 8, very nearly.

Taking, therefore, the strength of the parallel rail as correct, at seven inches from the end, it must be too weak in the middle, in the proportion of 8 to 5; and we may, consequently, from these premises, draw the following conclusions, viz.: Had the Liverpool Railway been laid with parallel rails, 35 lbs. per yard, the breakage would have been increased in the ratio of nearly 5 : 8, and the place of fracture would have been midway between the bearings, instead of seven or eight inches from the end. If we take the weakest part of the elliptical rail, as calculation gives it, viz.: nine, instead of seven inches, then the proportional breakage would have been as 6 : 8.

I am fully aware that some risk is incurred in thus endeavoring to represent numerically a comparison which is perhaps not susceptible of rigid calculation; but I am anxious that the truth on this much disputed point should be elicited, and in this attempt to establish a comparison upon grounds partly experimental and partly theoretical, it is believed a numerical statement will tend to define that which I am not aware has hitherto been more than mere matter of opinion, and thus bring the subject more within the grasp of legitimate argument.

In concluding these remarks, I beg leave to state that, if I have in any part of them betrayed a bias in favor of the elliptical rail, without a sufficiently powerful reason, I shall have pleasure in hearing it pointed out, with a view to correction. I have endeavored sincerely to give the subject that impartial consideration which its importance demanded, and I need scarcely add that it has given me some satisfaction to find that the experimental and theoretical results coincide sufficiently. This satisfaction is enhanced, when I find that the conclusion in favor of the elliptical rail is consistent with the opinion and experience of Mr. John Dixon, of the Liverpool and Manchester Railway—of Mr. Thomas Storey, the engineer on the Stockton and Darlington Railway—and of Mr. Nicholas Wood, one of the Directors of the Newcastle and Carlisle Railway, to whom I am indebted for the table of experiments embodied in these remarks. The circumstances which gave rise to these experiments have already been explained, and I am enabled, through the kindness of Mr. Wood, to add a copy of the report of the deputation from the Board of Directors of the Newcastle and Carlisle Railway, appointed to examine the subject by experiment. I also add copies of letters received from Mr. Wood and Mr. Storey.

COPY OF REPORT OF DEPUTATION ALLUDED TO ABOVE.

Result of trials made at Walker Foundry, October 10th and 31st, 1832, to show the comparative merits of Fish-bellied and Parallel Rails.

"Various experiments were made, but those which appear to the committee to

have more immediate reference to the views of the directors, are the following.

"Three trials were made of fish-bellied rails, of 50 lbs. per yard; three trials of parallel rails of the same weight; and two trials of fish-bellied rails, weighing 40 lbs. per yard.

"The weights laid on in these trials reached different amounts, but 90 cwt. is taken in the following for each trial, which the committee conceive to be a load sufficient to meet any practical object. The weight of the steelyard was 6 cwt., and 14 cwt. was added each time; the measure of deflexion was taken in parts, 1088 of which go to an inch.

"The first six loads (90 cwt.) on the three trials of 50 lbs. fish-bellied rails, measured 164½ parts of deflexion, which give an average of 9.14 parts as the mean advantage on each 14 cwt. loading.

"The first six loads (90 cwt.) on the three trials of 50 lbs. parallel rails, measured 230 parts of deflexion, or an average of 12.77 parts mean advance for each 14 cwt. loading.

"The first six loads (90 cwt.) on the two trials of 40 lbs. fish-bellied rails, measured 185 parts of deflexion, averaged 15.41 parts mean increase of each 14 cwt. loading.

"Rejecting fractional figures, the committee consider these results to show, under the circumstances stated, that a fish-bellied rail of 45 lbs. per yard is equal to a parallel rail of 50 lbs. per yard, because, as just expressed, nine parts represent the 50 lbs. fish-bellied rails, twelve parts the 50 lbs. parallel, and fifteen parts the 40 lbs. fish-bellied, bringing the parallel, as nearly as need be, midway between 50 lbs. and 40 lbs. fish-bellied rails."

(Signed,) B. Thompson,
N. Wood,
R. W. Brandling,
W. Losh,
Jas. Thompson,
Fras. Giles,
W. Woods.

—

COPY OF A LETTER FROM MR. WOOD.

Killingworth, 24th May, 1834,

My dear Sir: As the information you required was the result of private experiments, I did not like to give it until I had the sanction of the directors, which I now have. The experiments were occasioned by a difference of opinion whether parallel or fish-bellied rails were best, and, to bring the question before the directors in the most decisive manner, experiments were ordered to be made upon both rails—Mr. B. Thompson furnishing the section of parallel, and the fish-bellied being furnished by myself. Enclosed are the sections, by which you will see that the wearing surface, or top, of the rail, and the base, were precisely the same; the extreme depth of the parallel being 4 in., fish-bellied 5 in.; the base of the latter being a semi-ellipse, 3½ in. deep, 1½ in. from the end of each three feet, the curved knob being three inches. The experiments were conducted with the greatest care, and the deflexion measured in 1088th parts of an inch. The weights were added 14 cwt. at a time, upon 6 cwt., the weight of the steelyard.

Taking the first 96 cwt. laid upon the middle of the rail, the rail being supported at each end, the deflexion was $\frac{55}{1088}$ parts of an inch, fish-bellied; $\frac{77}{1088}$ parts of an inch, parallel, of 50 lbs. per yard each; and $\frac{93}{1088}$ parts of an inch 40 lbs. fish-bellied; although the conclusion come to by the directors was, that the parallel 50 lbs. was equal to the mean between the 50 and 40 lbs. fish-bellied, viz.: $\frac{55 + 98}{2} = 76\frac{1}{2}$ 1; the comparative stiffness of 50 lbs. parallel and fish-bellied rails, was as 55 : 77.

As, however, the directors took every thing into consideration, the form of the two rails, the fact that the saving of material in fish-bellied being only in the keel of the rail, the conclusion that a 45 lbs. fish-bellied is equal to a 50 lbs. parallel, is, I believe, a just estimate of their comparative merits. We have found the circular knob an excellent form for securing a good material of iron, as it is difficult to form with the common iron. Any other information on the subject I shall be happy to give you. I am, my dear Sir, yours very truly,

(Signed,) Nich. Wood.

To Robert Stephenson, Esq.

—

EXTRACT FROM MR. STOREY'S LETTER.

St. Helen's, Auckland, May 31, 1834.

Dear Sir: In reference to the subject of the form of rail best suited to railways, on the Stockton and Darlington Railway, you know we have only the fish-bellied kind, which form I have invariably supported, as the strongest, and best suited for railways, with the least weight of material in them, and liable to be the least affected by lateral blows, on account of the point of support being nearest the centre line of the mass of iron forming the rail.

One point is settled with me—that the better the quality of iron, the less it is suited for railway bars.

I have used rails made from Scrap No. 2 Mine Iron, with a Swede bar on the top; Cable Iron, manufactured into rails; No. 2 Mine Iron, do.; with none of which I am yet satisfied.

I have lately ordered 250 tons of rails

(to replace our light ones) for the Stockton and Darlington Railway Company, to be manufactured in a different way; which, if I succeed in getting of the fish-bellied shape perfect, I am of opinion will be found to answer the purpose.

If I do not succeed in that shape (without faults and cracks on the under side) it is my intention to resort to the parallel rail, as of that shape there can be no doubt of its answering.

The process I have described is, that good strong mine iron is to be used, that has passed through the refinery and puddling furnaces, and reduced, under the forge hammer, from seven to five inches square, before rolling into rails. The price is only a shade higher than if manufactured from No. 2 mine iron *bars*, and 10*s*. per ton more than the parallel bar of the same quality and manufacture.

You will find that very heavy malleable iron rails are subject to rapid decomposition on the surface, until they attain the strength that passing weights will give motion to the particles, when that decomposition will, in a great measure, cease; thereby proving my theory, that beyond a certain weight is a wasteful and useless expenditure. Dear Sir, yours always, truly,

(Signed,) THOMAS STOREY.

To ROBERT STEPHENSON, Esq.

—

On the above report to the Directors of the Newcastle and Carlisle Railway, I have little to remark, except to explain the apparent discrepancy which would seem to exist, on comparing the results taken as the basis of the report, with those described by the table furnished to me by Mr. N. Wood. In the report, other trials were alluded to, with which the results are blended, so that the average is below those stated in the table. The other experiments were, I believe, varied by allowing the rails to be placed loosely on the supports, when the superiority of the elliptical rail, as regards stiffness, was not so decided. The table is founded on experiments, where the rail was firmly keyed into the chairs, and was, therefore, more nearly in the condition of a railway in perfect order. This, I apprehend, will account for the relative stiffness of the two rails being stated as 55 : 77, whereas calculation gives it 55 : 85, and, by the table, where the rail was firmly keyed to the supports, it is 55 : 91.

It is also necessary to explain that the elliptical rail was made with a circular projection, which fitted into a corresponding recess in the bottom of the chair, according to Mr. W. Losh's patent. This would render the keying more efficient, and add a little to the rigidity of the elliptical rail.

This may probably account for the stiffness by experiment sometimes exceeding that represented by calculation, which ought not to be the case where the form of the beam is reduced in depth towards the end. The comparative stiffness, however, taken from the average of the experiments, as stated in Mr. Wood's letter, viz. as 55 : 77, does not differ so much from 55 : 85, as to shake our confidence in the theoretical view affording means for a tolerably near approximation.

The relative ultimate strengths are not mentioned in the report, but from the table they may be found to be as 12 : 15, and calculation gives 12 : 16, which is again sufficiently near to show that the principles adopted in the calculations are correct.

In Mr. Storey's letter, he mentions, in a particular manner, the difficulties he has had with respect to the quality of the iron employed in making rails; and though he expresses it as his opinion, that "the better the quality of the iron, the less it is suitable for railway purposes," I am persuaded he intends this to be taken with great limitation, as it is evident he would not mean to convey the converse, viz.: that the *worse* the quality of the iron, the *better* it is suited for railway purposes.

Mr. Storey is not alone in the opinion that the railway iron should not be of the best quality; it is urged by many that iron of the best quality is liable to laminate more rapidly than iron of a poorer description. I cannot say that my experience has led me to this conclusion; yet there may be consistency in rejecting the use of the finest cable iron, as not forming a rail proportionally stronger with the increased expense. I think it not improbable that much of the evil complained of on the Darlington Railway, from the lamination and splitting of the rails, may be owing, in some degree, to the circumstances of the carriages being without springs, and some of the very heavy locomotive engines with springs applied in such a manner that they operate only to a partial extent.

On the Warrington and Newton, on the Leicester and Swannington, and on the Stanhope and Tyne, Railways, I recommended the rails to be made from *best No. 2 bar iron, entirely free from cinder*. The rails, when manufactured, are, therefore, No. 3 mine iron. This mode of manufacture would give rails of similar quality to those weighing 28 lbs. per yard, laid down on the Stockton and Darlington Railway in 1825, which, I was surprised to learn from the chairman, were in better condition now, after several years' wear, than some rails of 40 lbs. per yard, recently laid down.

Railroad Locks.

To the Editor of the Railroad Journal:

Sir,—Locks on railroads, like most other departures from established modes, will have to contend with ridicule and opposition; and whether their merits can sustain their pretensions, experience must determine. Public safety, without regard to pecuniary considerations, demands some other than the present method of surmounting elevations, by inclined planes and stationary steam engines; and locks are now proposed for public consideration, as a substitute. The immense capital already contemplated to be invested in railroads, (42 being completed, and 146 projected,) the spirit of emulation that exists in several States, to surpass each other in that mode of intercourse, and the general predilection prevailing throughout the Union in their favor, gives any probable improvement in the safety, economy, and convenience of their construction, claims worthy of attention. The numerous inventions that are daily urged on the public, of no practical utility, and the pertinacity with which men adhere to preconceived opinions, render it difficult, without great exertion, to bring into general and immediate use designs highly important to community.

Improvements, however, are so rapid, and the country has derived such acquisitions of general prosperity and convenience, from steam navigation, railroads, and canals, that locks, so internally connected with a favorite subject of public interest, may find less difficulty of access to public patronage and confidence, than usually attends new designs. In presenting the subject to the public, the relative claims of railroad locks, and inclined planes and stationary steam engines, to the important considerations of safety, economy, and expedience, will be submitted, though the latter of the two modes being the only one in use, will not require other than general remarks. It is justly observed by Mr. Smith, editor of Wood's Treatise on Railroads, that inclined planes and stationary steam power "are an opprobrium to the present advanced state of civil engineering;" and they certainly betray a greater want of invention than displays itself in any other case, where the necessity of improvement is so evident.

That method of surmounting altitudes, since its adoption, has been a subject of complaint in England, and the fatal disasters they have occasioned strongly pressed for their discontinuance. In the United States, their destructive effects are not as generally known, or yet as severely felt; but the frequent accidents attending their operations on the Alleghany Mountains, and other places, have produced sentiments of disapprobation, that are gaining ground in the public mind. The only recommendation that inclined planes have to sanction their continuance is speed; and that, in the opinions of reflecting men, will not compensate for the least of the three objections to that mode of ascending. The views of the editor above alluded to are pertinent, and express the sentiments of those acquainted with the danger, expense, and inconvenience of that mode of ascending; he observes, "hence, any available plan, which will enable locomotive engines to ascend, with their full complement of wagons, without the intervention of stationary engines, and their appendages, will be a most valuable addition to the utility of railways, and unless the weight to be overcome be greater, compared with the length of the whole line, the delay resulting from a diminution of speed will be a trivial inconvenience, when the advantages of dispensing with an expensive stationary power are estimated." It is not probable that locks, such as are contemplated by Mr. Taylor, the inventor, occurred to Mr. Smith, as they embrace all the requisites he requires for an elevating power, with the additional and most important one of perfect safety. W. G.

[From the Journal of the Franklin Institute.]

Report on Mr. M. W. Baldwin's Locomotive Engines.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania for the promotion of the Mechanic Arts, to whom was referred for examination certain improvements in Locomotive Engines, made by Mr. Matthias W. Baldwin, of the City of Philadelphia, REPORT:

That they have examined several of these engines, which are now being built in Mr. Baldwin's workshop, and find in them numerous improvements, affecting nearly every part of the machine. The first they will notice are in the position and construction of the force pumps, which supply water to the boiler; the guides of the piston rods are made hollow, and the cavities are used for the chambers of the force pumps, thus giving additional strength to the guides, without much increasing their weight, and dispensing entirely with the frame and fixtures of the ordinary force pumps. Each of these pumps is furnished with five valves, three of which are situated between the boiler and the piston, and two between the piston and water tank. The valve nearest the boiler is loosely swivelled to a stem, passing through a steam-tight collar in the top of the valve box, by means of which the valve can be sounded, and, in most cases, freed from obstructions.

The other four valves are contained in one box; this box is secured to the pump by a stirrup, which can be removed by loosening a single screw, so that the valves can be taken out, cleansed, and replaced, in a few minutes. By thus increasing the facility of examining and cleansing the valves, and thereby diminishing the liability of the force pumps to obstruction, the supply of water to the boiler will be rendered much more regular and certain; and the chief causes of those fearful explosions incident to steam engine boilers will be in a great measure removed, as it is confidently believed that these accidents are generally the result of a deficiency in the supply of water.

Another improvement consists in the manner of reversing the motion of the steam valves. This is done in the English engines by means of a treadle, and a series of levers, which move the eccentrics laterally on the propelling axle, after the hooks of the eccentric rods are thrown out of gear with the rock-shafts. In Mr. Baldwin's engines, the arms of the rock-shafts extend on opposite sides of the fulcrum, and each eccentric rod is furnished with two hooks, turned in opposite directions, so that it may be geared to either arm of its rock-shaft; the eccentrics are fixed immovable upon the axle, and the eccentric rods, instead of being carried (as they usually are) to the front of the engine, are brought to the stage at the hinder part, and there geared to either arm of the rock-shafts, at the option of the engineer. When the hooks of the eccentric rods are geared to the same arms of the rock-shafts as the valve rods are, the motion of the valves corresponds to that of the eccentrics; if they be geared to the opposite arms, the motion of the valves will be reversed; and if they be not geared to either arm, the rock-shafts and steam valves can be worked by the hand levers. The advantages of this arrangement are several; the eccentrics being firmly secured to the axle, are less liable to get loose, and out of repair; it dispenses entirely with the treadle, and its appendages, and also with four rock-shafts, and the complicated hand-gear of the English method.

But the most important benefit is, that the rock-shafts and eccentric hooks are placed immediately under the eye, and within the reach, of the engineer, which is not the case in the ordinary arrangement.

The axle of the driving wheels has also been made the subject of improvement by Mr. Baldwin. Instead of fixing the ends of the axle into the centres of the wheels, as is usually done, he dispenses with one of the arms in each crank, and fixes the wheel upon the wrist of the crank, with its centre adjusted to the centre of the axle. By this change in the form of the axle, the power of the engine is applied directly to the wheel, without the intervention of an arm of the crank, thus diminishing the strain upon the axle, and, consequently, lessening its liability to be broken. By this means, also, Mr. Baldwin has, in some measure, obviated the tendency of the driving wheels to twist upon the axles, and become loose; a very general and troublesome defect of locomotives. Another good effect, resulting from this change, is that the distance between the two cranks is increased about ten inches, which will admit of a corresponding enlargement of the boiler, and of a more advantageous disposition of the weight of the fireplace, by bringing it about fourteen inches nearer the axle. In these engines, the steam pipe is introduced into the boiler through the opening by which it usually communicates between the dome and the cylinders; and the end of the pipe beneath the dome is supported on a horse, fixed within the boiler, so as to admit of its longitudinal expansion and contraction by changes of temperature; and to avoid inconvenience from the same cause, the stop of the throttle valve is fixed on the steam pipe, instead of the head of the boiler. A twofold benefit is derived from this plan of introducing the steam pipe: first, the pipe may be made without a joint within the boiler; and secondly, a man hole in the boiler may be dispensed with; for the juncture between the dome and boiler, as well as all the other steam joints, being accurately fitted by grinding, and formed without any cement, or packing, the dome can easily be taken off and replaced, and its aperture used for occasional access to the inside of the boiler.

In the construction of his driving wheels, Mr. Baldwin uses hubs and spokes of iron, cast in one piece; felloes of hard wood are framed into the ends of the spokes, and the whole is firmly bound together by a stout tire of wrought iron, with a flanch on its inner edge; thus, by a judicious combination of iron and wood, he has united the strength and firmness of the former with the elasticity of the latter, so desirable in the tread of the wheel.

Mr. Baldwin has completed several engines, which combine all these improvements; one of them may be seen in operation on the Philadelphia and Trenton Railroad, and four on the state road to Columbia; all of which, as well as one in use at Charleston, South Carolina, have given entire satisfaction by their performance.

The committee are informed that some of these improvements have been secured to their inventor by patents; and that he

richly deserves to reap the benefit of them, will be admitted by any one who is aware of the present extensive use and increasing demand for these costly structures.

By order of the committee.

WM. HAMILTON, Actuary.

February 12th, 1835.

HAYS' EASY CHAIR.—It is a common mode of expression, when we are about to refer to or speak of a new invention, to say, "we have before us," &c., but in this case a departure from the usual mode of expression is necessary, as we have *beneath* us one of Mr. B. F. Hays' easy chairs, invented for the comfort and convenience of invalids. It is, indeed, an *easy* chair; but may, with very little trouble, be converted into a bed, or a cradle, having two sets of rockers, one for the chair, and one for the bed or cradle—or they may, if desired, in order to effect a change of position, be thrown into gear, and used on the chair, in the same manner as when it is used as a cradle. It has also a set of rollers, by which it may be moved to any part of the room without incommoding the invalid. There are also conveniences for accommodating a lame limb—which may be supported and sustained at any desired angle, from a horizontal to vertical position.

There are other and peculiar conveniences about this chair, which can only properly be understood by examining it, which may be done at any time by calling at the office of the Mechanics' Magazine, or the New-York American.

The annexed engraving and references will give something of an idea of it; but nothing short of an actual enjoyment of its comforts, can give a correct idea of its merits.

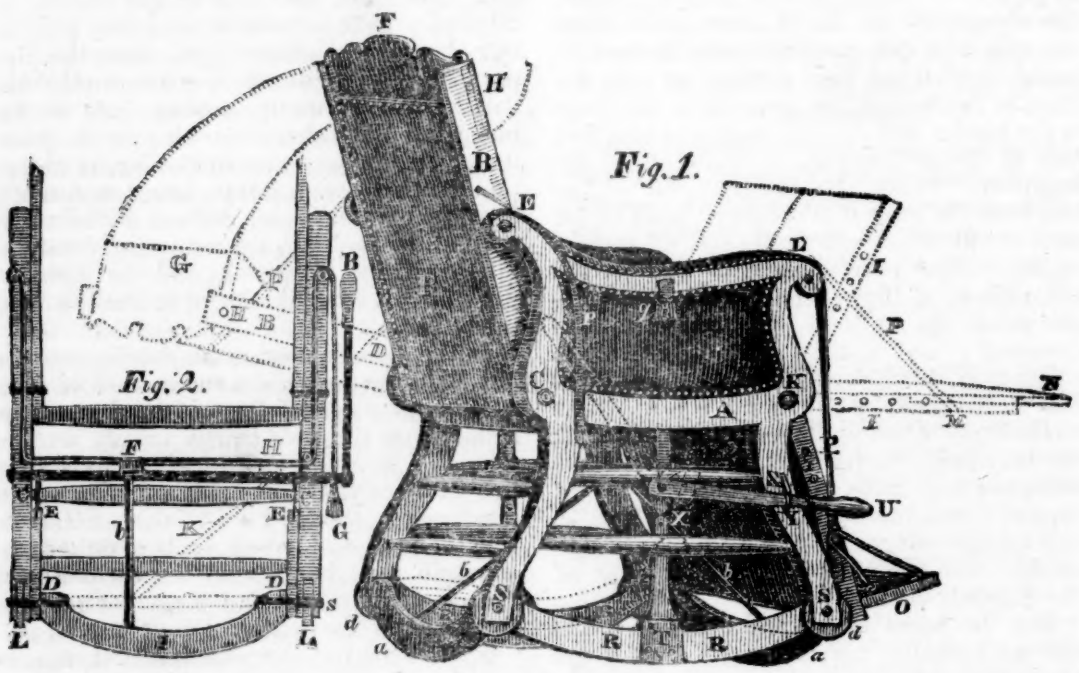


Fig. 1, *Angling view of Chair.* A, frame work of suitable strength and dimensions; B, back, turning on pivot C, made fast at any angle by a strap and buckle, as D and E; F, head-piece, turned up on pivot H for head-boards, as G; I, foot-pieces, made in two parts, either of which raised on the pivot K to any angle, and fastened by strap and buckle, as at L M; N, sliding pannels, drawn out for a bed; O, foot-board, raised or lowered at pleasure; P, strap, holding back and foot pieces; R, side rockers, with a joint at T, and sliding socket; S, pivots for rockers; V, friction rollers, moving in a sliding mortice at the end of

rockers in joint; U, lever, fixed to an arbor, short arms meet the socket in pitman T, making a joint at X; Y, fastening for lever, which being firmly and carefully raised into the position defined by the dotted lines, the side rockers are drawn up, leaving the chair resting upon the cross or cradle rockers, *a*; *bb*, rods, confining cross rockers to sliding bar; *g*, strap passing on rollers, moving the sliding bar back and forth on the arbor, folding the cross rockers into a horizontal, or pressing them out into a perpendicular position, while the chair rests on side rockers; *d*, rollers.

Fig. 2, *showing a Sectional View cross-wise.* A, arbor; B, lever; C, short arm of lever joined to arbor at X, and making a joint at socket or pitman at E; D, end of side rocker; F, end of sliding bar; G, straps, by drawing which the bar is moved on the arbor to H; *b*, rods, folding in the cross rockers to a horizontal position, (turning on the pivot S,) and lying on the angle K; L, edge of rollers.

The whole is plain and simple in its construction, fitted for all the purposes of the nursery and parlor, adapted to all classes of invalids, easily changed into a great variety of positions to suit dropsical, asthmatic, and rheumatic patients—cheap, and of convenient size, light and portable, easily conveyed from one apartment or place to another. It is well calculated for journeying with weak and feeble persons, affording a comfortable bed, when needed by the way; well calculated for a hospital, surgeon's, or dentist's chair, and not less adapted for all the ordinary purposes of a common rocking chair, or a single bed, in a private family or public office.

[From the Journal of the Franklin Institute.]

List of American Patents which issued in September, 1834.

1. For a Perpetual Shoe Bench; Samuel Haynes, Malden, Middlesex county, Massachusetts, September 1.

2. For an improvement in navigation, called the Cylinder Boat; Amos Kendall, city of Washington, District of Columbia, September 2.

3. For a Thrashing Machine; Israel Lukens, Upper Dublin, Montgomery county, Pennsylvania, September 2.

4. For an improvement in the application of steam to the purpose of cooking, called the Steam Baker; Charles F. Wilcox, Springfield, Hampden county, Massachusetts, September 3.

5. For machinery for Cutting Crackers; Lucius Kirtland, New Haven, New Haven county, Connecticut, September 4.

6. For an improved press, for Pressing Cheese; Elijah Barnes, North Brookfield, Worcester county, Massachusetts, September 5.

7. For a machine for Hulling Barley; Henry Handschey, Bridgeville, Muskingum county, Ohio, September 5.

8. For Wheels for Carriages, &c.; Barney Ruggles, Warsaw, Genesee county, New-York, September 8.

9. For a Shoe for Mill Cans; James Dennis, Providence, Rhode Island, September 8.

10. For a Circular Saw Mill; John Penman, Charlotte, Muhlenburg county, North Carolina, September 9.

11. For Lessening Friction, by friction rollers; Isaac Clowes, Norfolk, Norfolk county, Virginia, September 9.

12. For improvements in Locomotive Engines and Cars, for Railroads; Matthias W. Baldwin, Engineer, Philadelphia, September 10.

This patent is obtained for several improvements, which are claimed in the following words:

"What I claim as my improvement in the respective parts of locomotive engines and cars, herein described, is, first, the manner of constructing the crank, and inserting the wrist thereof, prolonged, into a socket in the wheel, or otherwise attaching it thereto, for the purpose of obtaining the advantages set forth. Secondly, the casting the wheel with the arms, or spokes, separate from each other, and attaching them to a rim, or felloes, of wood, by separate flanches. Thirdly, the manner of constructing the pump chamber, so as to fit it together without any packing, and to confine the respective parts in their places by means of a stirrup, operating in the manner described; and also the forming the chamber of the pump itself within one of the guide pieces. Fourthly, the general manner of constructing and adapting the junctures of steam, or other tubes, without packing, as set forth; not intending, however, in

either of the cases referred to, to confine myself to the precise form and construction represented in the drawings, but to vary the same in any way by which I may be able to attain the same ends by analogous means." [See page 278.]

13. For a Brick Machine; Cyrus Chaney, North Prospect, Waldo county, Maine, September 11.

14. For a Stove; James Wilson, city of New-York, September 12.

15. For an improvement in the Horse Collar Block; Dyer Cleaveland, Owego, Tioga county, New-York, September 13. [See vol. iv., page 362.]

16. For a Relief Bedstead, for the use of invalids; David Anthony, Adams, Berkshire county, Massachusetts, September 13.

17. For a new Material for Stuffing Mattresses; Elias Howe, Cambridge, Middlesex county, Massachusetts, September 13.

18. For an improvement in the construction of Water Cisterns; Obadiah Parker, Syracuse, Onondaga county, New-York, September 15.

19. For an improved Re-action Water Wheel; John L. St. John, Canajoharie, Montgomery county, New-York, September 16.

20. For a Handling Machine, to be used in the manufacturing of Leather; William G. Waterman, Sullivan, Madison county, New-York, September 16.

21. For an improvement in the form and construction of Gridirons; Fenner Bush, and Linus Pratt, Meriden, New-Haven county, Connecticut. First patented July 21st, 1832. Patent surrendered, and re-issued upon an amended specification, September 17.

22. For a Straw Cutter; Nimrod Murphrie, Nashville, Davidson county, Tennessee, September 17.

23. For Sun Dials of Cast Iron; Heman M'Cluer, Hamburg, Erie county, New-York, September 17.

24. For a Horse Power; Sewall Gleason, Westville, Franklin county, New-York, September 18.

25. For a Rotary Steam Engine; William Sutton, Geneva, Ontario county, New-York, September 18.

26. For a Churn; Adna L. Norcross, Hallowell, Kennebec county, Maine, September 19.

27. For Shears for Cutting Metal; George Christian, Mentz, Cayuga county, New-York, September 20.

28. For an improvement in the Forcing Pump; James D. Egbert, Lansing, Tompkins county, New-York, September 22.

29. For a Horse Power; Silvanus Leonard, Hampton, Penobscot county, Maine, September 23.

30. For an improvement in the Cast Iron Fireplace; Ansel Hayward, Easton, Bristol county, Massachusetts, September 25.

31. For an improvement in the Dress of Mill Stones; Isaac W. Elmore, Lyons, Wayne county, New-York, September 25.

32. For a machine for Thrashing and Cleaning Grain, and for Shelling Corn; David Knauer, East Nantmeal, Chester county, Pennsylvania, September 25.

33. For a Centripetal Power Press; Eliphalet S. Scripture, Cazenovia, Madison county, New-York, September 26 [See page 247.]

34. For Water Wheels; Garet H. Heermance, Coxsackie, Greene county, New-York, September 30.

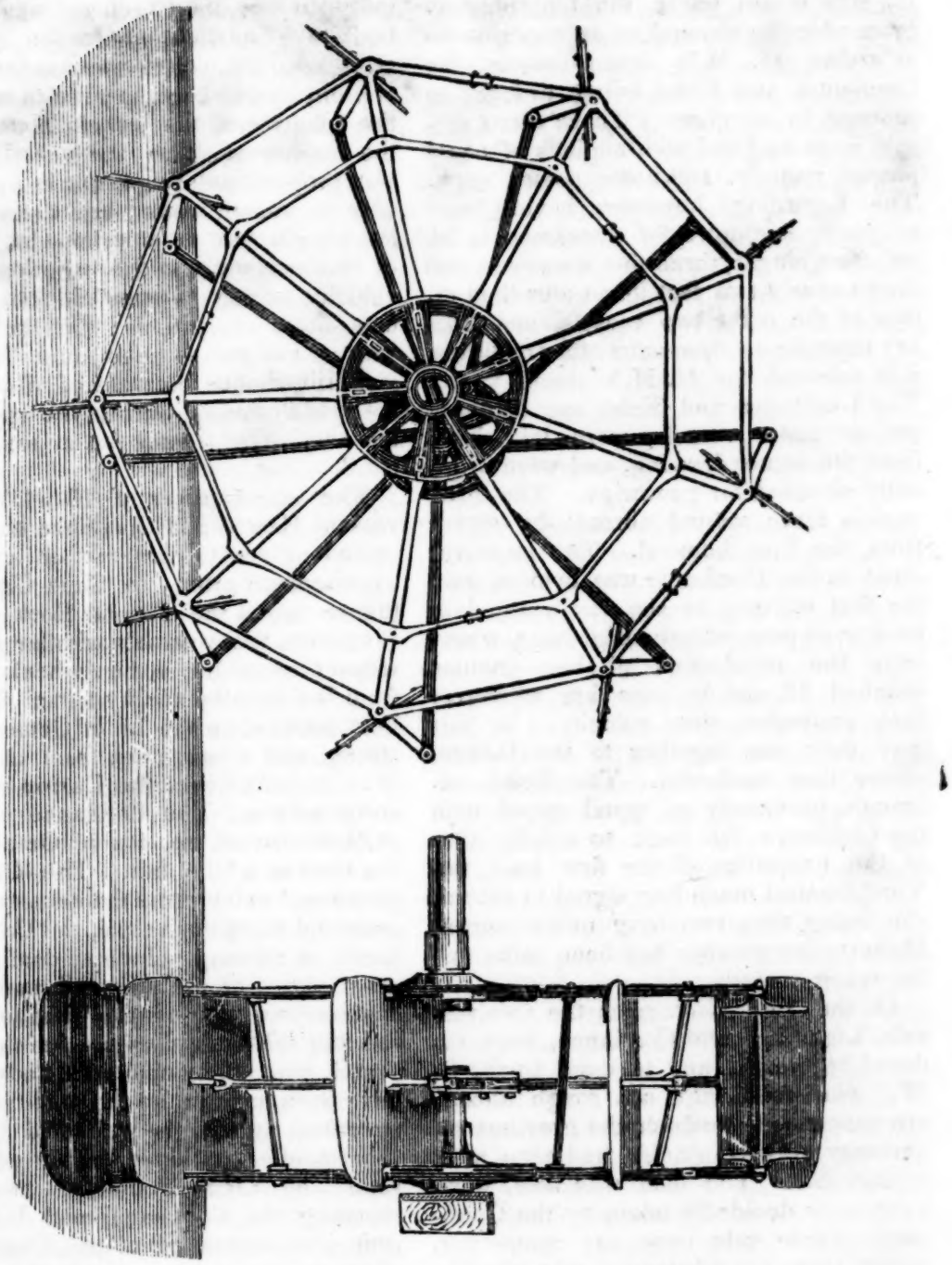
35. For an improvement in Stoves for Burning Anthracite; William A. Hopkins, city of New-York, September 30.

36. For a Tin Baker; Josiah St. John, Hudson, Columbia county, New-York, September 30.

[From the London Mechanics' Magazine.]

Morgan's Paddle-Wheel in its Latest and Most Approved Form.

The paddle-wheel now commonly known by the name of *Morgan's*, was originally invented by Mr. Elijah Galloway, and patented by him in 1829. The first trial made of it was on board a steam vessel, of which Mr. Wm. Morgan was the principal and acting owner, who was so much pleased with its performance that he became by purchase the proprietor of the patent. The Commissioners of the Admiralty were afterwards induced to order that a pair of these wheels should be fitted by Mr. Morgan to H. M.'s steam vessel Confiance. On the 9th of September, 1830, Commodore Warren, accompanied by Mr. Lang, of the Dock-yard, Woolwich, proceeded down the Thames in the Confiance, on an official trial of the wheels.



The Report made by the Commodore to the Admiralty, was, "That with 23½ revolutions of the engine, (24 to 25 revolutions being their regulated speed,) the vessel had improved in speed (as far as could be collected from so limited a trial) from 1 to 1½ knot an hour; that although the floats, in leaving at such rapidity, must necessarily disturb the water, so perfectly were the ill effects of the back-water obviated, that when the vessel was going at her utmost speed, he had caused a wherry, which was being towed a-stern, to be hauled up along-side, and close up to the paddle-box, without the slightest inconvenience, or without her shipping even a spray; and finally, that the previous vibration suffered from the action of the wheels was so reduced as to be barely sensible on the paddle-box itself."

On the 11th of September, Admiral

Sir Geo. Cockburn embarked on board H. M.'s steam yacht, the Lightning, to proceed to the channel on an experimental cruise, H. M.'s steam vessels, the Confiance and Echo, being ordered to proceed in company. These three vessels were all fitted with engines of equal power, namely, 100-horse power each. The Lightning, however, having been originally laid down for a steamer, is fifteen feet longer, three feet narrower, and draws nearly two feet less water than either of the other two vessels, and from her superior swiftness and other qualities, was selected for H. M.'s steam yacht. The Confiance and Echo are in every respect sister vessels, were laid down from the same drawing, and were originally intended for gun brigs. The three vessels were started abreast by signal from the Vice-Admiral. The improvement in the Confiance was evident from the first starting, as she was enabled to keep even pace with the Lightning, whenever the revolutions of her engines reached 23, and to pass her whenever they exceeded that velocity. In this way they ran together to the Downs, where they anchored. The Echo, although previously of equal speed with the Confiance, fell back so rapidly, that at the expiration of the first hour, the Vice-Admiral made her signal to return, she being then two long miles astern. Hitherto the weather had been calm, and the water smooth.

On the 12th September the two vessels, Lightning and Confiance, were ordered to weigh, and to stand to the S. W., wind fresh, and sea rough ahead, circumstances in which the previous superiority of the Lightning had been most remarkable. The lead was now, however, very decidedly taken by the Confiance, whose gain over her competitor, under these circumstances, was about a half knot on seven miles per hour, that being the speed at which the Lightning was driven.

The following day the Confiance was ordered to New-Haven, and accordingly started at 8½ A. M., wind strong, and heavy sea from W. S. W. At 4 P. M., off Beachy Head, she passed H. M.'s steamer Carron, (which vessel had left the Downs five hours before her,) making the best of her way to Plymouth on service. Having performed the service required of her, the Confiance was ordered back to Woolwich, where she anchored September 14. The commander, Lieut. Belson, having been ordered to report on the behavior of the wheels, stated "that the improvement in the vessel's speed was proportionately greater in a sea-way than in smooth water; that the action of the wheels was no way impeded by that of the waves, since the variation in the velocity of the engines did not exceed one to two revolutions; that the vessel's way was never stopped; and that there was no sensible increase of vibration on the paddle-boxes during the gale, over the very slight tremor felt in smooth water."

The commanders of H. M.'s steam vessels Carron and Confiance having received orders to proceed on a further experimental cruise to Cape Clear, and thence round the Fasnet Rock back to Plymouth, these vessels, similar in every respect, excepting in their wheels, started from the Breakwater by signal from the Port-Admiral on the 1st of October, wind strong, and a rough sea from the W. S. W. In five hours the Carron was hull down astern. The Confiance anchored at Hamoaze on the 4th of October, and the Carron on the 5th. The Confiance performed in 54 hours the distance which occupied the sister vessel, the Carron, 84 hours in running. Independently of the great saving of fuel effected, namely, 10 bushels per hour on the time saved in running the same distance as the sister vessel, viz., 30 hours, other advantages have been secured by the modification in question, as may be collected from the reports officially made, jointly and separately, by Lieut. Potburry, then commanding the Confiance, and Lieut. Lapidge, in command of the Carron. In reply to the questions put to them by the Admiral commanding at Plymouth, in virtue of directions from the Commissioners of the Admiralty, these officers stated, "that the Confiance had, on a comparison of their respective logs, gained by the alteration in her wheels an increase of speed of 2 knots on 7 in smooth water, and 2½ knots on 4 to 4½ knots in rough weather; that the action of the paddles did not bring up the engines or retard their velocity in a head sea; that

in rolling, their action assisted in righting the vessel, and that the wear and strain, as well on the vessel as on the engines, was materially reduced."

The superiority of the new wheel was considered to be so decisively established by these trials with the Confiance, that Mr. Morgan was subsequently employed by the Lords of the Admiralty to apply it to the other government steamers—the Flamer, the Firebrand, the Columbia, the Spitfire, and the Lightning. We extract the following particulars respecting the performances of these vessels, from the evidence lately given on the subject by Mr. Morgan, before the select committee on Steam Navigation to India, and from the official reports of their respective commanders to the Admiralty:

The Flamer displaces 590 tons (including 120 for engines, 140 for coals, and 30 for stores); her cylinders are of 42 inches diameter, and 4 feet stroke; and her wheels 18 feet in diameter, and 5 feet 6 inches wide. When the vessel is deep, her wheels revolve from 14 to 20 times per minute in rough water, and 26 times per minute in smooth. When the vessel is light, the speed of the wheels is increased from 18 to 22 revolutions in rough water, and from 26 to 26½ in smooth. The commander of the Flamer, Lieut. Bastard, in report of 23d January, 1834, says of the wheels, "in six weeks of most tempestuous weather, found them to act remarkably well, without even a single float being shifted."

The Firebrand was built on the same lines, and is of the same scantlings, as the Flamer, with the exception of having 9 inches more depth; she had also originally 20 horses more steam power. Her paddle-wheels were at first of the common sort, and then her velocity was three quarters of a mile less than that of the sister vessel, with wheels of Mr. Morgan's construction. But since the Firebrand has been supplied with Morgan's wheels, she has attained nearly the same speed as the Flamer; and this though her old engines have been replaced by a new pair, of no greater power than those of the Flamer—namely, two sixty's.

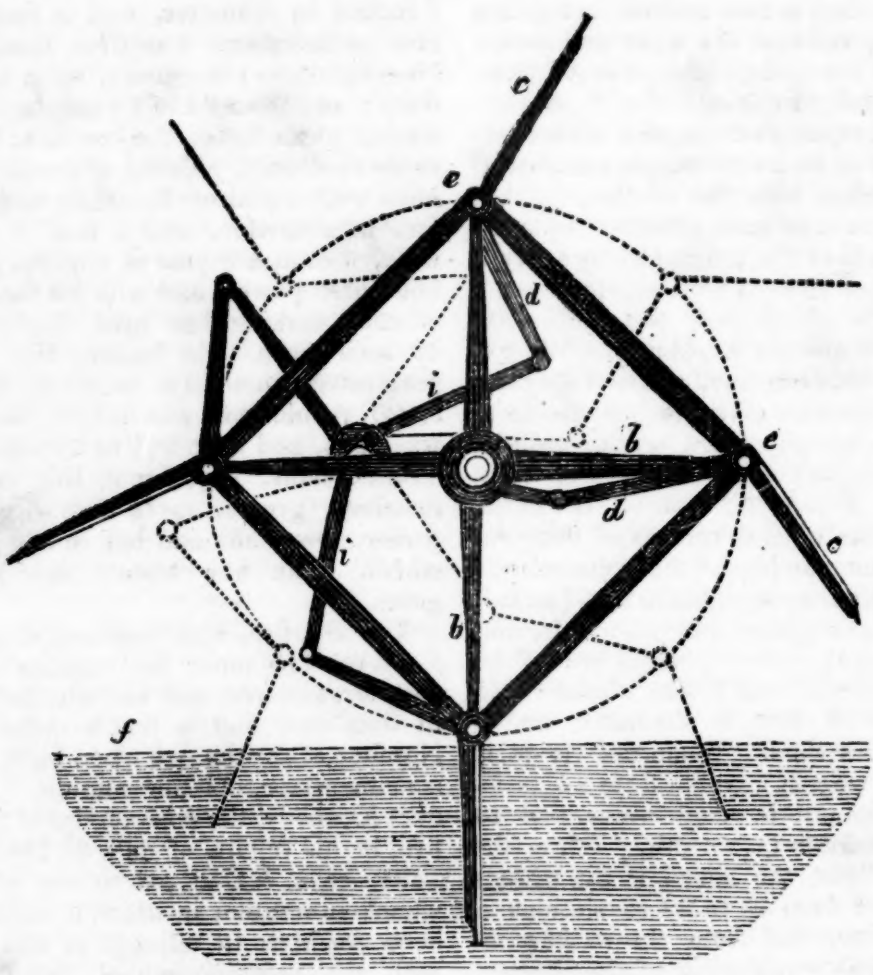
The Columbia, as originally constructed, displaced altogether 480 tons; her engines were of 120-horse power, and her wheels (of the common sort) 16 feet 6 inches in diameter, and 8 feet wide. Her performance was then from 14 to 16 revolutions per minute, when she was deep; and from 24 to 26 revolutions per minute when light; the weather in both cases favorable. Being afterwards supplied with a pair of Morgan's wheels, 17 feet in diameter, and 5 feet 2 inches wide, with a new pair of engines of only 100-horse power, and with 30 tons more of coal, making her total displacement 40 tons more than before, the wheels performed, in similar weather, from 20 to 25 revolutions per minute when she was deep, and from 26½ to 28 when light. "She obtains," says Lieut. Ede, her commander, "greater speed than with the superior power she had before and the old wheel. The new wheels save the engines."

The Spitfire, with engines, coals, &c. displaces 715 tons; her engines are of 140-horse power, and her wheels 20 feet in diameter, and 4 feet 9 inches wide. Number of revolutions when light, and in smooth water, 23 per minute. Lieutenant Kennedy, the commander of the Spitfire, in his report, of date 3d December, 1834, says, "Had put to sea with the wheels in weather in which it would have been madness to attempt in any vessel with the common wheel, but that she had gone over it 4½ knots an hour, without scarcely feeling the wheels moved. With the old wheels would have been forced to put back, but had with these (Morgan's) made his passage from Gibraltar to Falmouth against a heavy gale nearly the whole way."

The Lightning has been before described. Her commander, Mr. Allen, in reporting on the effect produced on her rate of going, by the adoption of Mr. Morgan's wheels, says that "the speed was much improved in heavy weather," and "the vibration nearly done away with."

The wheels of the Medea, the largest war-steamer yet constructed by the British Government, the Tartarus, and Blazer, are also on Mr. Morgan's plan.

During the last summer, Mr. Morgan was employed to fit a pair of his wheels to his Sardinian Majesty's steam-vessel Gulnare; and it is from these wheels, the latest (we believe) manufactured by Mr. M., that the drawings have been made.



The wheel, as now constructed by Mr. M., embraces a good many improvements on the original design of Mr. E. Galloway. The most prominent difference is an increase in the number of radial arms and paddles, from four to nine. To show how much the wheel has gained from the successive modifications which experience has suggested, we here annex an engraving and description of it in its original form, as given by Mr. Galloway himself, in his "History and Progress of the Steam-Engine":

"The object of this wheel is to provide a remedy for the loss of power, and other inconveniences arising from the oblique position in which the float-boards of the common paddle-wheels enter and leave the water. This the inventor purposes to effect by causing each float-board to turn, or rather vibrate, on an axis at its edge next the centre of the paddle-wheel, through the medium of projecting levers, firmly fixed to the float-boards, at their axis of motion, and connecting rods proceeding from the extremities of these levers to the extremity of a *fixed crank*, adjustable at a given distance from the centre of motion of the paddle-wheel, which consists of four radiating arms, connected at their extremities by strengthening braces; *b b* represent the four arms of the wheel, and *e e* the strengthening braces; *c c* are the paddles, firmly fixed to which are the levers *d d*, forming angles of about 120 degrees with each other, and turning together on axes at *e e*; *f* represents the water-line; *g* is the crank, fixed centrally to the axis of the wheel, but so as not to revolve with it; this crank is alterable at pleasure, by means of a set screw, which causes the paddles, through the medium of the connecting rods *i i i*, to take such an angle with the water-line as may be deemed most desirable for propelling; the rods *i*, however, are connected to a revolving collar on the crank, which allows of free rotary motion, while it draws the paddles uniformly into the positions shown in the

engraving, when the arm of the crank is set in a horizontal position, as represented. The dotted lines show the position the paddles assume in the intermediate parts of their revolution, or the relative position they would take if there were eight paddles attached to the wheel."

The following communication is handed us by Mr. Ormsby, in reply to one published in the April number of the Mechanics' Magazine, signed J. K. Our correspondent was mistaken, it seems, inasmuch as Mr. Ormsby has never intimated that he was the inventor of the art; he claims to be the inventor only of the particular machine with which he works. It was by no means our intention, nor that of our correspondent, to detract from Mr. O.'s merits, but merely "to place the feather in the right cap," which Mr. Ormsby is also desirous to do.

Pentography.

To the Editor of the Mechanics' Magazine:

Sir,—In the April number of your periodical is an article on "Engraving in Relief," to which I feel called upon to reply, as it contains some important misstatements concerning myself.

The writer says, "Every well-wisher to the cultivation of the fine arts must have been gratified at observing the progress that has been made during the last few months in this elegant department of engraving. To me it is a matter of surprise that it should be *brought forward now as a new invention*," &c.; and in the coucluding paragraph, he says, "It is with unfeigned surprize and regret, that I observe Mr. Ormsby of this city *advertises himself as the inventor of the art.*" Now, if these assertions were correct, it would undoubtedly puzzle me much to "say in what possible shape I can have any claim" to that honor; but I am not aware that it has been "brought forward now as a new invention;" and I certainly have not advertised, or represented in any manner whatever, myself "as the inventor of the art." It seems to me that your correspondent should have either *qualified* his assertions, or taken more pains to inform himself correctly.

About eighteen years have elapsed since the invention of this beautiful style of engraving by Messrs. Gobrecht and Spencer, of Philadelphia; and the reason why it has not been brought into extensive use before, I am unable to say; but the fact that it has *not*, accounts for the prevalence of the opinion that I am the original inventor of the art, which is an honor I feel a pleasure in ascribing to the above named gentleman.

The first notices of my machine speak of its being the "*process of medallion engraving heretofore carried on laboriously by hand*; but now, with this machine, it can be carried on to any extent, without any human agency, after the plate and the copy are once adjusted, and the mechanism, of which a weight is the moving power, is set to work."

Here is the sum and substance of my invention; and all I ever pretended to claim, is the particular, and, as I believe, improved construction of my machine, which is self-operating.

Respectfully yours,

W. L. Ormsby.

New-York, April 9, 1835.

Experiments in Assaying.

To the Editor of the Mechanics' Magazine:

Sir,—I am engaged in the iron trade, and had an intention to erect a blast furnace a few years since for smelting iron from the ore of a new bed, and was naturally desirous, before doing so, to ascertain as nearly as possible what were its qualities. I therefore commenced assaying it and some other ores found in the neighborhood; but I soon concluded that the methods described in the books, which direct the use of "calcined borax, pounded bottle glass, chalk, &c." were not suited to the object which I had in view, namely, to ascertain what kind and quantity of iron might be expected from the ore when used in the large way in the blast furnace. I therefore laid those articles aside, and continued my experiments with the same materials which I expected to use when working the furnace; and the following memoranda show some of the results obtained.

December 2—Roasted 3 specimens of brown hematite ore;

No. 1 lost in weight 16.01 per cent.
2 do. 13.52 do.
3 do. 14.58 do.

	ozs.	dwts.	grs.	
Assayed	2	14	3	of the above ore with
		8	0	of limestone,
		8	0	of clay,
		10	0	of pounded charcoal.

The above, after being three hours in the furnace, produced 1 oz. 9 dwts. 9 grs. of metallic iron, equal to 54.27 per cent. The iron was tough, like the iron from a blooming fire.

Note—This experiment was not very satisfactory, on account of the iron not forming a good button at the bottom of the crucible.

No. 5. Assayed—

oz.	dwts.	grs.	
1	15	0	of roasted ore, with
	5	12	of clay limestone,
	5	12	of clay,
	7	0	of pounded charcoal,
	13	4	metallic iron.

The above produced, after 3 hours' heating, 1 oz. 13 dwts. of iron, which, after deducting the 13 dwts. of metallic iron added to the charge, left 19 dwts. 20 grs. for the produce of the ore, equal to 56.66 per cent. The slug was rather tough and infusible; the specific gravity of the iron, 7.238.

The foregoing, I dare say, is as much as you will desire at one time. Should yourself, or any of your readers, desire more, I shall be happy to furnish you with further extracts, and remain,

Your obedient servant,

J. D. W.

Vergennes, April 13, 1835.

J. D. W. will much oblige us, and we are sure our readers also, by giving further extracts from his memoranda of experiments.—[Ed. M. M.]

Magnificent Railway Viaduct. — We observe, from the Liverpool newspapers, that the North Union Railway Company have contracted with Messrs. Henry Mullins and M'Mahon, of Dublin, for the erection of a bridge or viaduct over the Ribble, which is to consist of five noble elliptical arches, of 120 feet each, being almost a fac-simile of the Waterloo bridge over the Thames. "The design," it is said, "was at first thought too expensive and elaborate; yet careful investigation, and the opinion of the most experienced bridge builders and masons, not only confirm the original and bold conception of the Company's engineer, Mr. Vignoles, but actually demonstrate that this is the most economical mode of taking a railway at the height of 70 feet across the river." The contract price is £35,000. The North Union Railway consists of two parts: 1st, of the Wigan Branch Railway, 7 miles long, which is already executed, and has been two or three years at work; and 2d, the Preston and Wigan Branch Railway, 15 miles long, which is now in course of execution, and is expected to be completed in three years from this time. Supposing the Birmingham Railway to be simultaneously completed, there will then be a railway communication the whole way from London to Preston.

Cements.—Mortar made of good lime and clean sharp sand may be successfully employed for the same purposes as Roman cement, provided it be allowed sufficient time to dry before water is permitted to rest upon it. This was mentioned many years ago by Arthur Young, in his "Agricultural Survey of Lincolnshire," and we have seen it proved in a variety of instances. In stuccoing the front of a house in or about London, for example, no builder need ever have recourse to any of the metallic cements, (including under this term *Roman cement*, *Parker's cement*, *Hamblin's mastic*, and all other quick-setting cements, which are only quick-setting in consequence of their containing some metallic oxide,) provided he can procure the best stone lime from Dorking or Aberthau. For our own parts, we should have more confidence in the durability of stucco so formed than in that of any of the cements. —[Mr. Loudon, Archit. Mag.]

Fall of a Suspension Bridge.—The beautiful suspension bridge, which crossed the Garonne at Porte St. Marie, by a single span, gave way at four o'clock on the morning of the 8th of January last, and was nearly entirely destroyed.